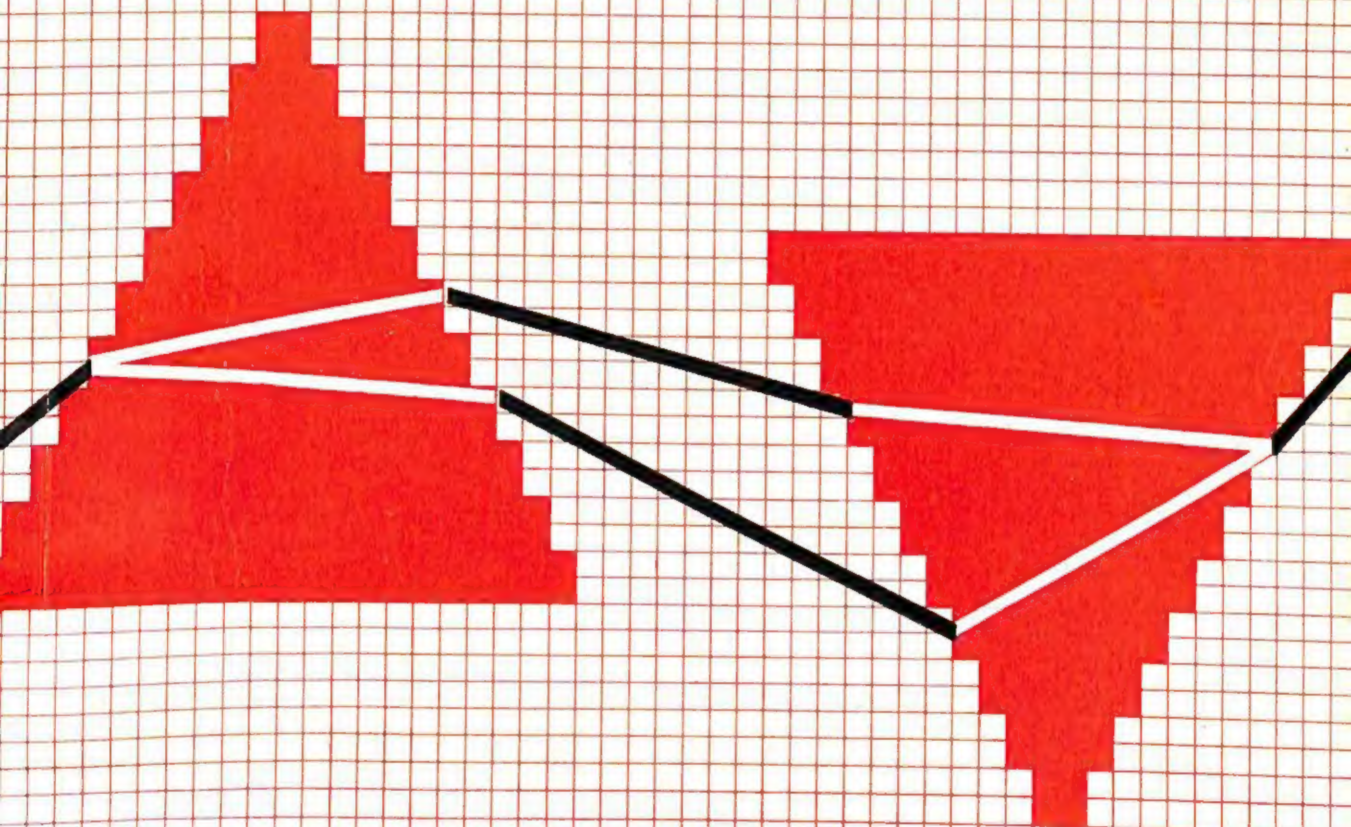
Understanding Science

PHYSICS

Class VII



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PHYSICS

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Motion

We see different types of motions around us every day. Birds and aeroplanes flying, vehicles moving on a straight road, or a ball rolling on the ground are examples of rectilinear motion. The motion of a top, hands of a clock and potter's wheel are examples of rotatory motion. The motion of the pendulum of a clock is oscillatory motion, while the vibrations in the string of a sitar constitute vibratory motion.

1.1 Uniform and Non-uniform Motion

When a train starts from a station, it first moves slowly. After some time, it picks up speed and runs fast. As it approaches a station, it slows down and finally stops.

Similarly, when a car starts it first moves slowly from rest. Then, as the driver presses the accelerator further, it starts moving faster. The speed of the car can be read on an instrument called the **speedometer,** fixed in the car in front of the driver. It measures the speed of the car in km/h. You must have observed that the needle of the speedometer is at zero when the car is at rest. It then moves to 10 km/h, 20 km/h and so on as the car moves faster and faster. If the car moves on a highway, where there is not much of traffic, the needle of the speedometer shows an almost constant speed of say 50 km/h. This means that the car is moving at a constant speed of 50 km/h, that is, it will cover 50 km in every one hour. If a body travels through equal distances in equal intervals of time, the motion of the body is called **uniform** motion. In uniform motion, a body moves at the same speed throughout its journey.

While driving if some persons or an object comes in the path of the car, the driver immediately puts his foot on the brakes and its speed decreases. In this case, or at the time of starting, the speed of the car does not remain the same. It covers unequal distances in equal intervals of time. Its motion is then said to be **non-uniform** motion.

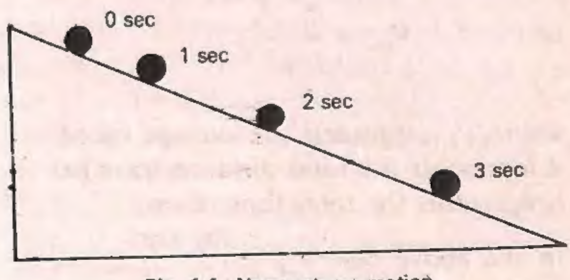
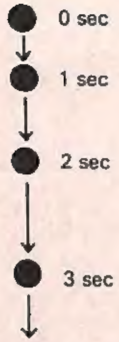


Fig. 1.1 Non-uniform motion.
(a) Body rolling down an inclined plane.



(b) Body falling freely under gravity.

Similarly when a fan is moving, its motion is uniform but when it is switched off, it slows down and gradually stops. Here the motion of the fan is non-uniform. The motion of a body rolling down an inclined plane or falling from a height is also non-uniform (Fig. 1.1).

Average Speed

Suppose you travel in an express train from Delhi to Lucknow. The distance between these two stations is 500 km. Suppose the train takes you to Lucknow in 10 hours. In these 10 hours, the train stops at a few stations. It moves slowly when it approaches or leaves a station. Its speed during the journey is therefore not constant and hence its motion is non-uniform. In such a case we find what is called the **average speed** of the train. It is found by dividing the total distance travelled by the total time taken.

$$\text{Average speed} = \frac{\text{Total distance}}{\text{Total time}}$$

or $$V_{av} = \frac{d}{t}$$

where V_{av} represents the average speed
d represents the total distance travelled
t represents the total time taken.

In the above case $$V_{av} = \frac{500 \text{ km}}{10 \text{ h}} = 50 \text{ km/h}$$

If the motion of the train had been uniform, with a speed of 50 km/h, throughout the journey, it would have covered the distance in 10 hours.

Activity 1: If you go to school on a bus, find the distance between your home and school from the kilometre readings in the speedometer of the bus. Record the time your school bus takes to travel this distance. Hence find the average speed of the school bus.

Velocity

When a body moves it has some speed and at the same time it moves in a particular direction.

Suppose two cars start from a crossing at the same speed of 50 km/h. One moves towards north and the other towards south. Both have the same speed but they have different **velocities** because they move in different directions.

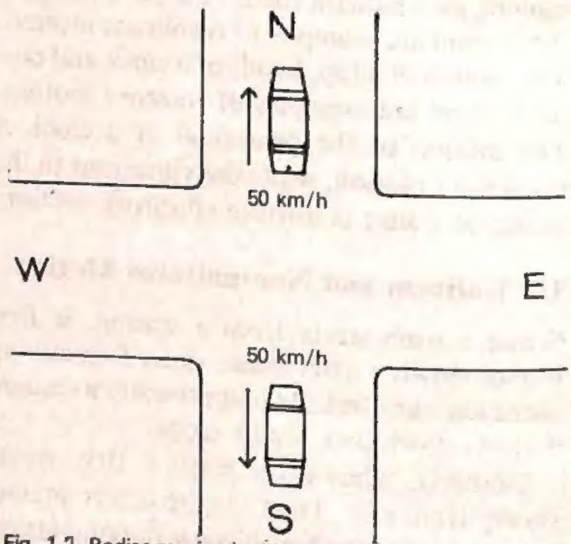


Fig. 1.2 Bodies moving in different directions with the same speed have different velocities.

Thus velocity of a body is its speed in a particular direction.

We specify velocity by stating both speed and direction. Thus a car moving at a constant speed of 50 km/h due North has a constant velocity. If it turns towards East and continues moving with the same speed, its velocity changes to 50 km/h due East.

Acceleration

We often see that when there is not much traffic on the road, a driver presses his foot on the accelerator and the car moves faster or is accelerated. Let a car travel at 36 km/h or 10 m/s. When the driver accelerates it, let its velocity increase by 5 m/s after every second i.e.;

After 1s its velocity becomes $10 + 5 = 15$ m/s

After 2s its velocity becomes $10 + 5 + 5 = 20$ m/s

After 3s its velocity becomes $10 + 5 + 5 + 5 = 25$ m/s

We say that acceleration of the car is 5 m/s per second, or 5 m/s^2.

Thus *acceleration is increase in velocity in a unit time.*

When a body falls from a height, it is attracted by the earth. Its velocity increases by 9.8 m/s every second due to the gravitational force acting on it. So such a falling body has an acceleration due to gravity of 9.8 m/s^2. The acceleration due to gravity is represented by g.

Retardation

Suppose a car is running at a high speed of 72 km/h or 20 m/s and the driver applies brakes to slow it down. Let its velocity decrease by 10 m/s after every second, i.e.;

After 1s its velocity becomes $20 - 10 = 10$ m/s

After 2s its velocity becomes $10 - 10 = 0$ m/s i.e. it comes to rest.

It will come to rest in 2 seconds. We say that the motion of the car is retarded and its retardation is 10 m/s per second or 10 m/s^2.

Thus *retardation is decrease in velocity in a unit time.*

1.2 Inertia

If we keep a book on a table and it is not displaced, it will remain in the same position unless and until some force is applied on it.

Activity 2: Take a piece of cardboard and place it on a glass tumbler. Place a coin over the cardboard piece. Strike the piece of cardboard sharply with your finger as shown in Fig. 1.3a. You will find that the coin falls into the tumbler while the cardboard flies away.

(a) The coin falls into the tumbler on striking the cardboard.

(b) The jam bottle remains in its position.

Fig. 1.3 A body at rest continues in its state of rest unless a force acts on it.

Activity 3: Spread a small sheet of paper on a table and place a jam bottle or a tumbler of water over it. Pull the paper suddenly. The bottle or the tumbler will remain in its position while the paper comes out (Fig. 1.3b).

From these experiments it is clear that a body continues to be in a state of rest unless a force is applied on it.

If you are riding a bicycle and you stop pedalling, the bicycle does not stop immediately. It comes to rest after covering some distance. So a moving body has a tendency to keep moving unless a force is applied to stop it. In the case of the bicycle it is the force of friction that ultimately causes the bicycle to stop. If the moving parts of your bicycle are well lubricated to reduce friction, the bicycle will travel a greater distance before coming to rest.

This tendency of a body to be in a state of rest or of uniform motion in a straight line, unless a force acts on it, is called **inertia.**

This can be put in the form of a law called **Newton's first law of motion.** It states that *every body continues in its state of rest or of uniform motion in a straight line unless a force acts on it.*

Some Other Examples of Inertia

When a moving bus suddenly stops we tend to fall forward. This happens because our feet in contact with the floor of the bus come to rest when the bus stops. But the upper part of the body, due to inertia of motion, continues to be in motion.

When a fan is switched off, it continues moving for some time due to inertia of motion. If a carpet is beaten with a stick, it is set into motion but the dust particles tend to remain in their positions of rest. So they get separated from the carpet and fall on the ground.

1.3 Mass

It is more difficult to push a heavy box than a light one. This is because a heavy box has more inertia than a light box. For the same reason, if a bus has a breakdown on the road, the passengers are asked to get down from the bus before it is pushed. The loaded bus has more inertia than an empty one. Inertia of a body is measured by a physical quantity called the **mass** of the body. *Greater the mass of a body, greater is its inertia.*

We also define mass as the *quantity of matter contained in a body*.

Measurement of Mass

The mass of a body can be measured by a beam balance as shown in Fig 1.4.

The beam balance consists of a beam supported at its centre. Two pans are suspended from its two ends at equal distances from the centre. There is a pointer attached to the beam which moves over a scale. There is a lever to raise or lower the beam. The body to be weighed is placed in one of the pans and standard weights are placed in the other pan. When the beam is raised, the pointer indicates whether the beam is balanced or not.

You must have seen a simple type of beam balance at a vegetable or ration shop for weighing vegetables, wheat, sugar etc.

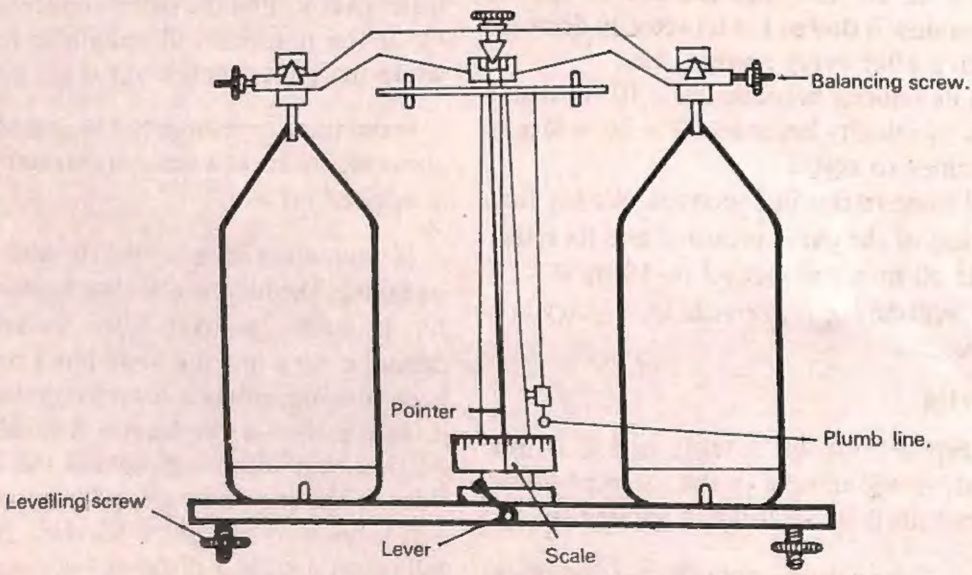


Fig. 1.4 A beam balance is used to measure mass.

Unit of Mass

The unit of measuring mass is kilogram (kg). One kilogram is the mass of the standard body made of platinum-irridium alloy kept in Paris. Copies of this standard kilogram are used in different countries. In India, a copy of this standard is kept in the National Physical Laboratory, New Delhi. The standard weights you can see in the market are copies of this. Submultiples of kilogram are gram and milligram.

$$1 \text{ g} = \frac{1}{1000} \text{ kg} = 0.001 \text{ kg}$$

$$1 \text{ mg} = \frac{1}{1000} \text{ g} = 0.001 \text{ g}$$

Difference between Mass and Weight

Mass is an inertial property of a body whereas weight, as we have learnt in Class 6, is the gravitational pull acting on a body. The pull of the earth, i.e. the weight of a body, decreases as we go higher. An astronaut gets a feeling of weightlessness in space since the force of gravity is zero in outer space. If he carries some sugar with him in space, sugar will be weightless. Does this mean that there is less sugar? If we measure the volume or the number of crystals of sugar, we find that its quantity is the same as on the earth. This 'something' which remains the same in space or elsewhere is known as mass. So mass remains the same everywhere whereas weight changes from place to place according to gravity.

Mass is measured in kilogram but weight is measured in kilogram-weight.

Mass is measured by a beam balance but weight is measured by a spring balance, as shown in Fig. 1.5. When a body is suspended by a spring, the spring is stretched and the amount of extension can be used to indicate the weight of the body.

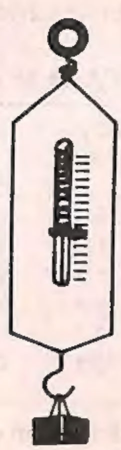


Fig. 1.5 A spring balance is used to measure weight.

1.4 Density

If we have 1 kg of cotton and 1 kg of iron, which will occupy more space? Surely cotton will have much more volume than iron (Fig. 1.6). We say that iron is **denser** than cotton. We define density as the *mass of a unit volume of a material.*

If we want to compare the densities of iron, glass and wood, we will have to take equal volumes, say unit volume (1 cc), of each substance and weigh them separately in a beam balance. The weight of 1cc of the substance will be the density in g/cc.

Fig. 1.6 1 kg of iron occupies much less space than 1 kg of cotton.

Table 1.1 gives the densities of some common substances.

TABLE 1.1

Substance	*Density* (g/cc)	*Substance*	*Density* (g/cc)
Mercury	13.6	Ice	0.9
Lead	11.3	Teak wood	0.48
Copper	8.9	Pure water	1
Iron	7.8	Sea water	1.025
Aluminium	2.7	Alcohol	0.79
Glass	2.5	Glycerine	1.26

If we take a block of iron of volume 10 cc and weigh it, we find that it weighs 78 g. Therefore 1cc of iron will weigh 78/10 = 7.8 g. We say that density of iron is 7.8 g/cc.

If volume of a body is measued in m^3 and mass in kilogram then density is measured in kg/m^3.

The density of a body is determined by dividing the mass of a body by its volume.

$$D = \frac{M}{V}$$

were M is the mass of the body, V its volume and D its density.

Density of water is 1000 kg/m^3. It means that $1m^3$ of water weighs 1000 kg. Let us see how much is the density of water in g/cc.

$1\ m^3 = 1\ m \times 1\ m \times 1\ m$
$= 100\ cm \times 100\ cm \times 100\ cm$
$= 100 \times 100 \times 100\ cc$
$1\ kg = 1000\ g$
Density of water $= 1000\ kg/m^3$

$$= \frac{1000 \times 1000\ g}{100 \times 100 \times 100\ cc} = 1\ g/cc$$

The knowledge of density of a substance is useful in construction of aircrafts and bridges, in separating certain liquids and petroleum products.

1.5 Action and Reaction— Newton's Third Law of Motion

During Diwali days all of you fire toy rockets. As soon as you ignite it, hot gases and smoke come out in the downward direction, with a force called **action.** These gases push the rocket up with a force, called the **reaction** (Fig. 1.7). The same principle of action and reaction ex plains the motion of jets and rockets also.

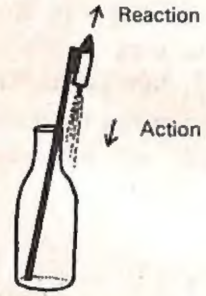


Fig. 1.7 Action and reaction in a toy rocket.

Activity 4: Take two spring balances and suspend them as shown in Fig. 1.8. Pull the lower spring balance with your finger. You will find that both the spring balances show the same reading. The lower spring balance applies a force of action on the upper balance, whereas the upper balance applies a force of reaction on the lower balance.

This experiment shows that *to every action there is an equal and opposite reaction.* This is known as **Newton's third law of motion.**

Fig. 1.8 Action and reaction are equal.

The action and reaction always act on different bodies. In a revolving water fountain, the water comes out of the nozzle in one direction with a force called action (Fig. 1.9). Due to reaction of the water fountain, the wheel revolves in the opposite direction.

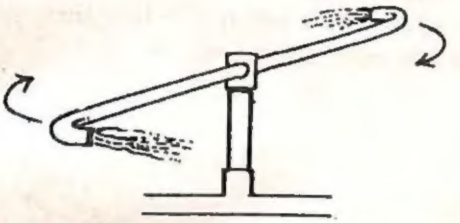


Fig. 1.9 Reaction of water coming out with a force causes a revolving fountain to turn in the opposite direction.

A book lying on a table exerts a force (action) equal to its weight, on the table. Since the book is at rest, an equal and opposite force (reaction) must be exerted by the table on the book.

When we walk, we push the ground backwards with our feet. This force is action. The ground, in turn, exerts an equal and opposite force of reaction on us and we move forward.

When a shell is fired from a cannon, the shell comes out of it with a force called action. The shell exerts an equal and opposite force on the cannon which recoils with a jerk (Fig. 1.10)

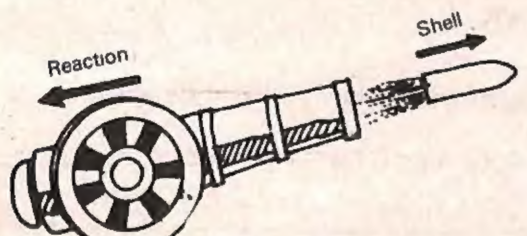


Fig. 1.10 The recoil of a cannon or a gun is because of the reaction to the force with which the shell or bullet is fired.

1.6 Friction

We have already learnt in Class 6 that friction always opposes the motion of a body, and comes into play due to the roughness of the surfaces in contact.

Types of Friction

Try to push a heavy box. You will find that if you apply a little force it does not move. It means that there must be some frictional force acting which is equal and opposite to the force applied by you on the box. This force of friction, when the box is not moving is called **static friction,** Fig. 1.11a.

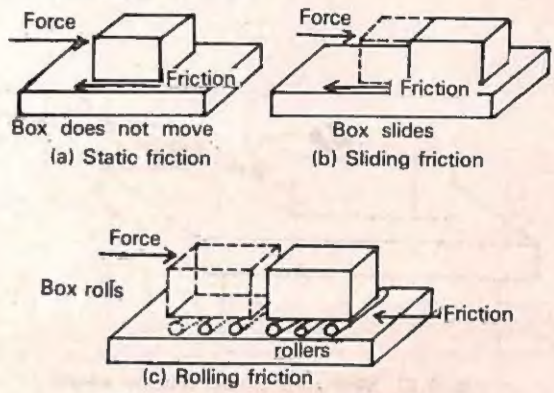


Fig. 1.11 Different types of friction

If you apply a large force the box starts sliding. The friction which then comes into play is called **sliding friction,** Fig. 1.11b.

If you place wooden rollers under the box, it has rolling motion rather than sliding motion and the friction that comes into play is called **rolling friction,** Fig. 1.11c.

Measuring Friction

Activity 5: Place a wooden block on a wooden table. Pull it by attaching a spring balance to one of its ends so that it just starts sliding. The pulling force as shown by the spring balance at that time measures the force of sliding friction (Fig. 1.12).

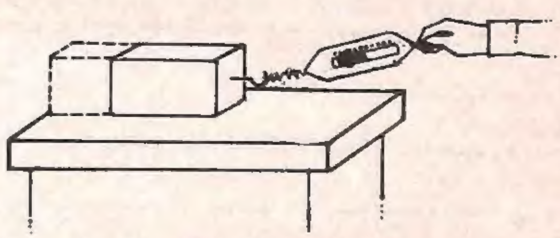


Fig. 1.12 Measurement of sliding friction.

Activity 6: Now place a weight on the same block. Again pull it so that the block just slides. You will notice that the pulling force required to move the block has increased (Fig. 1.13).

This shows that force of sliding friction depends upon the weight of the body. *Greater the weight of the body greater is the force of friction.*

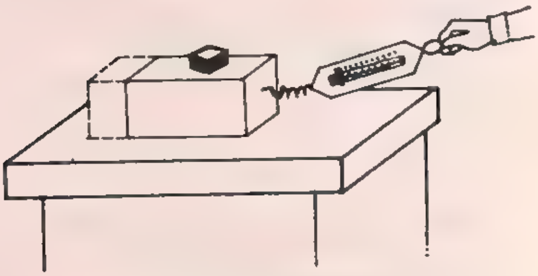


Fig. 1.13 Sliding friction depends on weight.

Activity 7: In Activity 5 replace the wooden table by a table having sunmica or glass top. Note the pulling force when the same block just slides. You will notice that the pulling force will decrease. This is because the top surface of the table is now smoother. This shows that *friction depends upon the nature of the surfaces in contact.*

Activity 8: Take the same block as in Activity 5. Place two or three round pencils or wooden rollers under it (Fig. 1.14). Pull the block so that it just rolls. You will notice that the pulling force has now decreased.

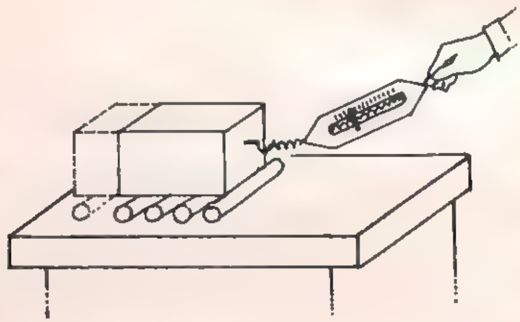


Fig. 1.14 Rolling friction is less than sliding friction.

Since the pulling force is a measure of force of friction, this shows that rolling friction is less than sliding friction. It is easier to roll a heavy body than to slide it.

EXERCISES

1. List five examples each of uniform and non-uniform motion. Also state whether the examples are of translatory, rotatory, oscillatory or vibratory motion. ______

______

______

______

______

______

______

2. What is the difference between (i) speed and velocity (ii) mass and weight (iii) sliding friction and rolling friction? Illustrate your answer with examples.

(i) ____________________

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____

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(ii) ____________________

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____

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(iii) ____________________

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3. A car covers 100 km with a speed of 50 km/h and another 100 km with a speed of 25 km/h. What is the average speed of the car? ____________________

____

____

____

4. A boy goes from his house to school in a bus which travels at a speed of 60 km/h and returns the same distance on the bus at a speed of 40 km/h. What is the average speed of the bus? ____________________

____

____

____

5. Why does a tennis ball have less inertia than a cricket ball? ________________

____

____

6 (i) When you stop pedalling a bicycle it does not come to rest immediately. Why?

____

____

____

(ii) Why does it come to rest after some time? ________________

____

____

____

(iii) If the bicycle tube has a puncture, why is it difficult to pedal the cycle? ______

____

____

____

7. How does Newton's third law of motion help to explain the need to push the river bank with a pole to launch a boat? ________________

____

____

____

8 Density of aluminium is 2.7 g/cc. What does it mean? ________________

____

____

9. A cubical tank of side 1m is filled with 1000 kg of liquid. What is the density of the liquid in kg/m^3 and in g/cc? What liquid is it? ________________

____

10. The density of iron is 7.8 g/cc. Find the mass of a block of iron if it is 1m long, 0.5m broad and 0.25m high. ______

11. State true or false.
    (i) Two trains going in opposite directions at the same speed have the same velocity.
    (ii) The motion of a stone dropped from a height is an accelerated motion.
    (iii) Force of friction accelerates the motion of a body.
    (iv) An astronaut will have less mass but same weight on the surface of the moon.
    (v) The mass of a unit area of a substance is called its density.
    (vi) Mass can be measured by a spring balance.
    (vii) Action and reaction always act on different bodies.

12. Fill in the blanks.
    (i) A body falling freely under gravity accelerates at the rate of ______ The acceleration is caused by the force of ______
    (ii) A body continues to be at rest until a ______ is applied on it.
    (iii) The tendency of a body to be in a state of rest or of uniform motion in a straight line, unless a force acts on it, is called ______
    (iv) If you are standing in a bus which starts suddenly you are likely to fall ______ (backwards/forwards).
    (v) The greater the ______, the greater is the inertia.
    (vi) In outer space ______ (mass/weight) of a body decreases.
    (vii) Density = ______ ______
    (viii) Every action has an equal and opposite ______
    (ix) More the weight ______ (more/less) the friction.
    (x) Rolling friction is ______ (less than/equal/greater than) sliding friction.

2

Liquid Pressure and Atmospheric Pressure

2.1 Liquid Pressure

We have already learnt that pressure is the force or thrust acting on a unit area. We exert pressure on the ground due to our weight. Similarly, liquids have weight. They exert pressure on the container in which they are kept

Activity 1: Take a glass tube. Tie a balloon to one of its ends. Hold it vertical and pour water into it. You will find that the balloon bulges out (Fig. 2.1). The bulge is due to the force exerted by the water column. The total force on the balloon is equal to the weight of the water column and is called **thrust.** If a is the area of the balloon, then the pressure exerted by the water on the balloon is

$$\text{Pressure} = \frac{\text{Total force or Thrust}}{\text{Area}}$$

i.e. $P = \dfrac{F}{a}$

If you pour more water in the tube the balloon bulges more. This is because the weight of the water, and hence the thrust, increases with the height of the liquid. Thus the pressure also increases with the height of the liquid.

The above experiment shows that liquids exert pressure downwards. We can also show by a similar experiment that liquids exert pressure sideways on the walls of the container.

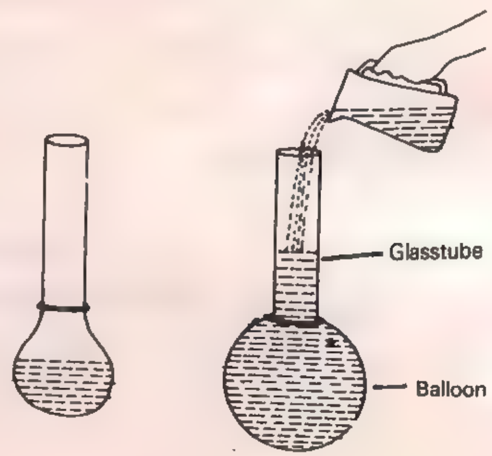


Fig. 2.1 Liquid pressure increases with height of the liquid.

Activity 2: Take a glass tube opening sideways. Cover opening of the tube with a balloon. Pour water in the tube. You will notice that the balloon bulges out (Fig. 2.2a). Add more water, the bulge increases because it is now at a greater depth from the surface of water. This shows that liquids exert pressure sideways on the walls of the container. The pressure in this case also, increases with the height of the liquid.

Since the pressure increases with the height of the liquid, the walls of a dam are constructed thicker at the bottom to withstand high pressure (Fig. 2.2b).

If we try to immerse a plastic mug into water, we experience that our hand is pushed up due to the upward thrust of water. Hence liquids exert pressure in the upward direction also. Thus we conclude that *liquids exert pressure in all directions.*

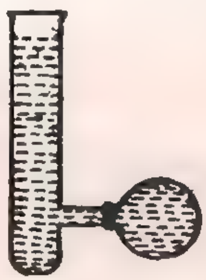
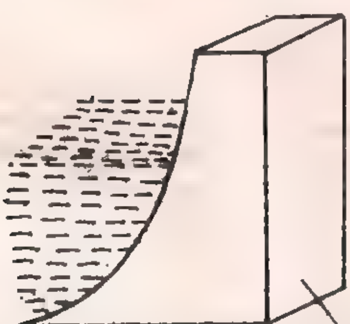


Fig. 2.2 (a) Liquids exert pressure sideways also.



(b) A dam is made broader at the base to withstand higher water pressure.

Activity 3: Take an empty tin (a talcum powder tin will do). Pierce three holes in it at different heights, one above the other. Close the holes with adhesive tape. Fill the tin with water. Remove the tape. You will notice that the water coming from the uppermost hole falls nearest to the can and the water coming out from the lowermost hole falls farthest from the can (Fig 2.3).

This experiment also shows that sideways pressure increases with the depth of the liquid.

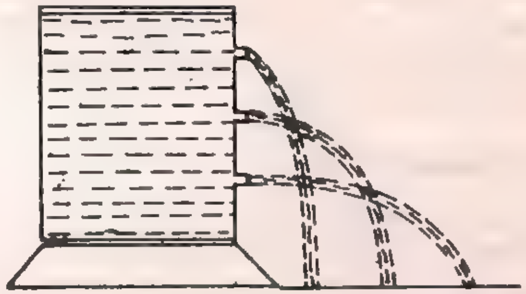


Fig. 2.3 Pressure in a liquid increases with depth.

Liquids Maintain Their Level

Activity 4: Take two funnels connected by a plastic tubing as shown in Fig. 2.4a. Pour coloured water into one of the funnels. Bring the funnels at the same level as in Fig. 2.4a. What do you observe? Mark the levels of water. Now raise one of the funnels and lower the other. Mark the levels of water again. What do you conclude?

You will notice that the level of water on the side raised goes down while it goes up on the other side, so that the water in the two sides stand at the same level.

Liquids always flow from higher to lower level until the levels are the same. Thus liquids always maintain their level.

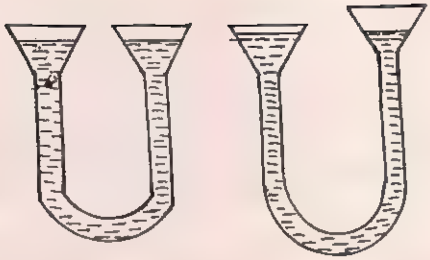


Fig. 2.4 (a) A liquid maintains its level.

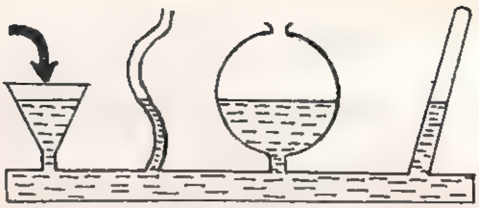


Fig. 2.4 (b) A liquid maintains its level.

This can also be demonstrated by the apparatus shown in Fig. 2.4b. Glass tubes of different shapes and sizes are connected together. If water is poured in any one of them, you will notice that the water in the other tubes will stand at the same level.

2.2. Pascal's Law

Activity 5: Take a balloon and fill it with water. Make a few fine holes in the balloon using a sharp pin. Squeeze the balloon. Water will come out of all the holes equally in all directions (Fig. 2.5).

The pressure exerted on an enclosed liquid is transmitted equally in all directions. This statement is called **Pascal's law** after the French scientist who first discovered this fact.

Fig. 2.5 Pressure exerted on an enclosed liquid is transmitted equally in all directions.

Let us consider a closed vessel with two cylinders fitted with pistons (Fig. 2.6). Let the area of the smaller piston A be 10 cm^2 and of the larger piston B be 100 cm^2. Suppose a weight of 2 kg wt is placed on the smaller piston. The pressure on the smaller piston A

$$= \frac{2 \text{ kg wt}}{10 \text{ cm}^2} = 0.2 \text{ kg wt/cm}^2$$

This pressure is transmitted equally in all directions throughout the enclosed liquid. It will push the larger piston up. The pressure on the piston B will be 0.2 kg wt/cm^2

Upward thrust (force) on piston B = Pressure × area = 0.2 kg wt/cm^2 × 100 cm^2 = 20 kg wt

The piston B can therefore lift a weight of 20 kg wt. Notice, however, that if piston A goes down by a certain amount, the piston B will go up by a lesser amount because of the larger volume of piston B. Thus, just as we saw in machines, what is gained in force is lost in distance.

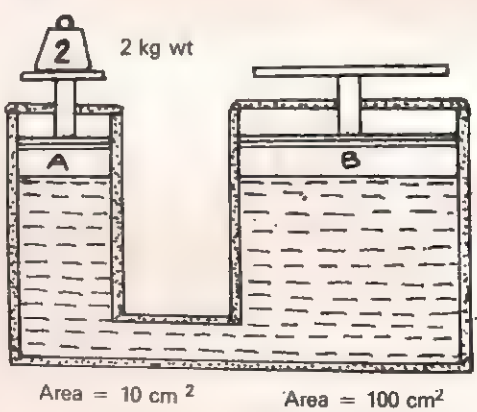


Fig. 2.6 Piston B can lift 20 kg wt.

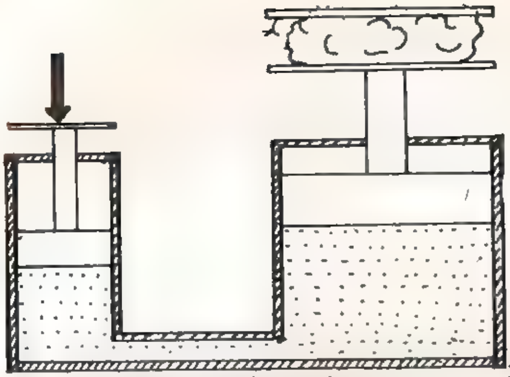


Fig. 2.7 A hydraulic press being used to compress a cotton bale.

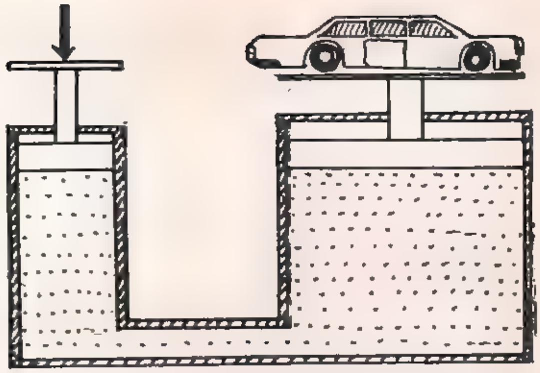


Fig. 2.8 A hydraulic lift being used to lift a car.

This principle is made use of in the construction of hydraulic press, hydraulic lift and hydraulic brakes. The hydraulic press (Fig. 2.7) is used to compress cotton bales. The hydraulic lift (Fig. 2.8) is used to lift heavy vehicles in motor garages for cleaning or repairing them. Hydraulic brakes are used in cars and buses.

2.3 Buoyancy

Activity 6: Tie a thick thread to a brick or a big stone and lower it in a bucket of water. What do you feel? As you lower it in water it feels lighter. Why is it so? The water in the bucket exerts an upward thrust on the brick. This upward thrust is called **buoyant force**. Due to the buoyant force the brick feels lighter. This buoyant force can be measured.

Activity 7: Take a solid, e.g. a metallic bob or a glass stopper or a brick. Suspend it from the hook of a spring balance and note its reading. It gives the weight of the body in air. Now immerse it completely in water and again note its reading (Fig. 2.9). It gives its weight in water. You will notice that the weight of the body in water is less than its weight in air. This is because a buoyant force acts on it. The difference of the weight of the body in air and its weight in water gives the magnitude of the buoyant force.

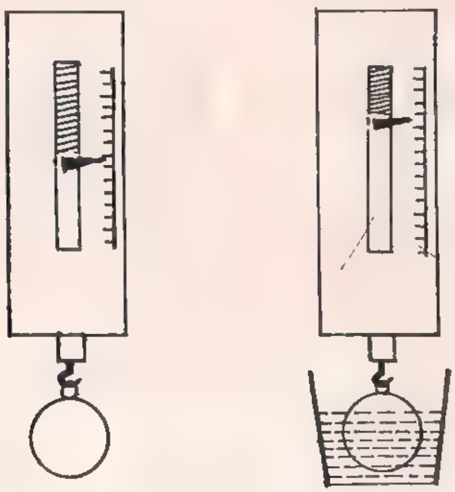


Fig. 2.9 Finding the buoyant force.

Activity 8: Take two bobs of the same weight, one of lead and the other of aluminium. Which bob will have more volume? Obviously, the aluminium one because its density is less than that of lead. Suspend them from two spring balances and immerse them completely in water kept in two beakers as shown in Fig. 2.10. You will notice that the reading of the spring balance from which the aluminium bob is suspended is less than the reading of the other spring balance. The buoyant force acting on the bigger aluminium bob is more than the buoyant force on the smaller lead bob, though their weights are equal.

This shows that the *buoyant force depends upon the volume of the body immersed. The greater the volume the greater is the buoyant force acting on it.*

Now suspend any bob from a spring balance and immerse it in different liquids, say water, glycerine and kerosene oil (Fig. 2.11). You will notice that the reading of the spring balance will be least when the bob is immersed in glycerine and it is maximum when the bob is immersed in kerosene oil. Glycerine is heavier than water and kerosene oil is lighter. Hence, the *buoyant force depends upon density of the liquid. More the density of the liquid more is the buoyant force.*

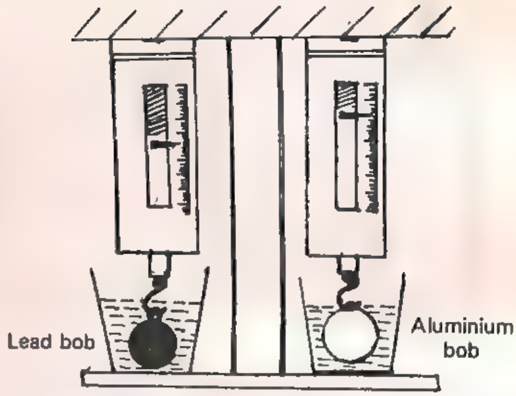


Fig. 2.10 Buoyant force depends on volume of the body.

Sea water is denser than river water due to its salt content. The buoyant force exerted by sea water is therefore greater and it is easier to swim in sea water than in river water.

2.4 Archimedes' Principle

Archimedes was a Greek philosopher. He was once asked by a Greek king to test the purity of gold in his crown without breaking the crown. He used the principle of buoyant force to test the purity of gold. Later he gave a principle known after his name as **Archimedes' Principle.**

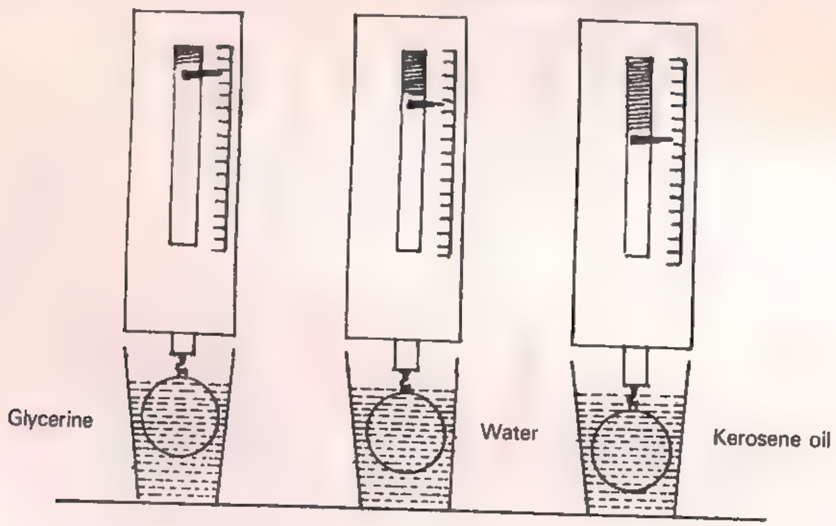


Fig. 2.11 Buoyant force depends upon density of the liquid.

Activity 9: Take a solid body. Suspend it from a spring balance and note the reading. This gives the weight of the body in air. Suppose it is 300 g wt. Take a plastic or metal can. Make a small hole in it near the top and insert a plastic straw in it (Fig. 2.12). Fill water in the can and allow the extra water to flow out through the straw so that the water level is just below the hole. Immerse the body completely in water. The body displaces water which overflows through the straw. Collect this water in a beaker. Note the spring balance reading. Let it be 160 g wt. The body loses its weight in water due to buoyant force of water acting on the body.

Loss of weight = 300 − 160 = 140 g wt
Weigh the collected water. You will find that the weight of the water displaced is also 140 g wt.

This result leads us to Archimedes' principle which states that *when a body is partly or completely immersed in a liquid it loses weight. The loss of weight is equal to the weight of liquid displaced.*

Fishes have air bladders inside their bodies. When a fish inflates its air bladder, its volume increases. So the buoyant force acting on it increases and it can rise to the surface. When it shrinks the bladder, its volume decreases, the buoyant force decreases and it sinks into water.

Boats and ships are designed in such a way that the buoyant force acting on them is high. This keeps them afloat in water.

Floatation

If the weight of a body is greater than the bouyant force exerted on it by the liquid, the body sinks in the liquid. But if the buoyant force acting on a body is equal to the weight of the body, the body floats in the liquid.

We see that an iron needle sinks in water whereas an iron ship floats on water. Why is this so? A ship has much larger volume as compared to that of a needle. So the buoyant force of water on the ship is very great and equals the weight of the ship. Hence it floats. The buoyant force on the needle is very small and is always less than its own weight, hence it sinks.

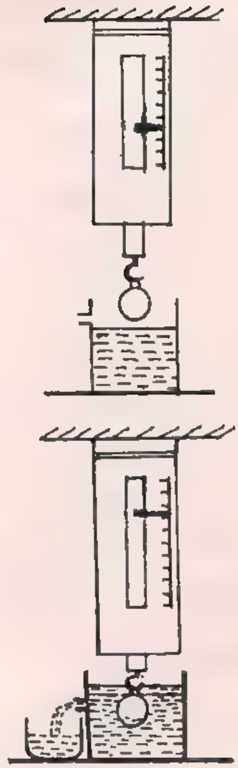


Fig. 2.12 Verification of Archimedes' principle.

A submarine can go under water or come up on the surface of water by changing its weight in comparison to the buoyant force of water. If it has to go under water, its ballast tanks are filled with water, thereby increasing its weight as compared to the buoyant force acting on it. When these ballast tanks are emptied the ship becomes lighter and the buoyant force pushes it up.

This principle is used to construct the **hydrometer.** It is an instrument used to compare and measure the densities of different liquids. Its principle can be understood by the following activity.

Activity 10: Take a pencil and attach enough plasticine to one of its ends so that it floats vertically in water (Fig. 2.13). Take water in a glass and mark the level to which it sinks in water. Now dissolve 2-3 teaspoons of salt in the water and put the same pencil in the salt solution. What do you observe? The pencil sinks less in the salt solution. Take kerosene oil in another glass and put the same pencil in it. You will notice that the pencil sinks more in kerosene oil. Why does the pencil sink more or less in the two liquids? Salt solution is denser than kerosene oil so it exerts a greater buoyant force on the pencil than that exerted by kerosene oil. This greater buoyant force makes the pencil sink less in the salt solution.

Air and other gases also exert a buoyant force like liquids. A balloon filled with hydrogen gas has less weight than the buoyant force of air, and hence rises up in air.

2.5 Air Pressure

Our Earth is surrounded by a blanket of air called the **atmosphere** which extends upto a height of several kilometres. We being at the bottom of this atmosphere of air are pressed by its weight. The pressure of the air above us is the weight of air acting on a unit area of surface. It is known as the **atmospheric pressure.** It is found to be approximately 1 kg wt per sq. cm. So the average pressure on our body is approximately 20 metric tonnes! This pressure is quite large. How is it that we do not feel it on our body? The reason is that there is air inside our body, and its pressure from inside balances the outside pressure.

Atmospheric pressure decreases as we go up on a hill or a mountain. As we go higher up the particles of gases in the air are less crowded, that is, the density of air decreases. Hence the weight of the air becomes less as the air becomes rarefied. Also the height and hence the weight of the air column pressing on us decreases as we go up.

Air pressure varies from place to place depending on its height from sea level. The pressure of air at sea level is taken as a standard called **one atmosphere.**

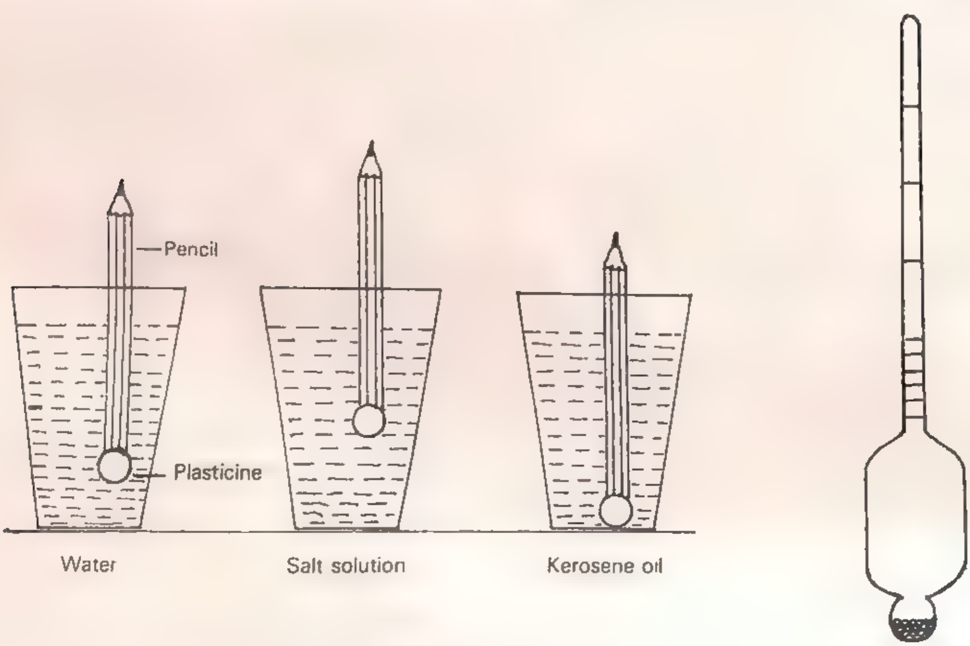


Fig. 2.13 (a) A home made hydrometer can be used to compare densities of liquids.

(b) A hydrometer to measure densities of liquids.

Air Pressure Acts in All Directions

Activity 11: Fill a glass tumbler completely with water. Cover it with a thin cardboard such that there is no air between the cardboard and water. Support the cardboard with your hand and invert the tumbler. Remove your hand gently from the cardboard piece. You will notice that the cardboard does not fall and water does not spill (Fig. 2.14). Why? Air presses the cardboard upwards and supports the weight of the water in the tumbler.

Press the carboard and turn the tumbler so that it is horizontal. Remove your hand gently. Once again you will notice that the cardboard does not fall.

This experiment shows that, just like liquid pressure, *air pressure also acts in all directions.*

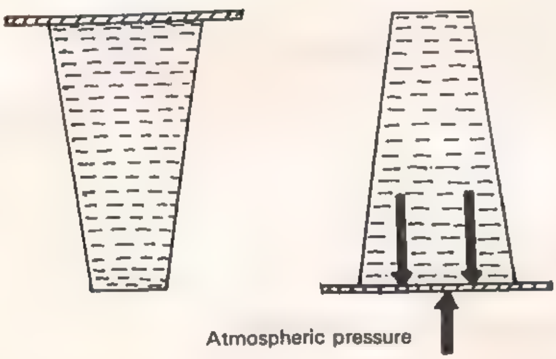


Fig. 2.14 Atmospheric pressure acts in all directions.

Activity 12: Boil some water in a tin with its lid open. A few minutes after steam begins to come out, close its lid tightly and stop heating. Pour cold water on it. The tin gets crushed and is deformed in shape (Fig. 2.15). Why? On boiling the water, the air is expelled out of the tin by the steam. The cold water poured on it condenses steam to water. The pressure inside the tin therefore becomes very low as compared to the pressure of air outside the tin. This extra pressure from outside acts on the tin from all directions and crushes the tin. This experiment shows that air pressure acts sideways also.

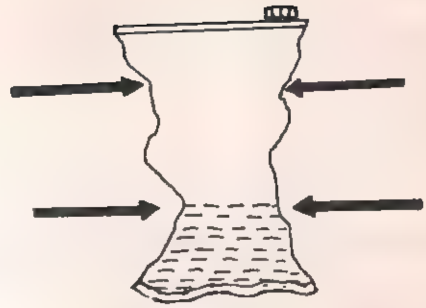


Fig. 2.15 Atmospheric pressure can crush a can.

Measurement of Air Pressure

The atmospheric pressure at a place is measured by an instrument called **barometer** (Fig. 2.16). A simple barometer consists of a one metre long glass tube closed at one end. It is filled with mercury and inverted in a trough containing mercury. The mercury level in the glass tube stands at a height of about 76 cm. So the pressure exerted by atmospheric air is equal to the pressure exerted by a column of mercury 76 cm high. If the barometer is taken to a hill station, the mercury level will drop, indicating a lower atmospheric pressure.

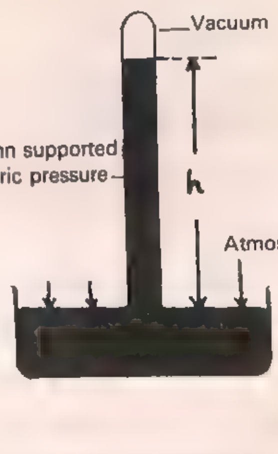


Fig. 2.16 A barometer.

Effects of Air Pressure

An aeroplane flies at a height of around 10,000m or more where the atmospheric pressure is very low. But the pressure inside the plane is maintained at one atmosphere. If this was not so, the pressure of air inside the bodies of the passengers would be much higher than the outside pressure. This may even cause bleeding from ears, nose and eyes. For the same reason, astronauts wear pressurised suits when they go to outer space where the atmospheric pressure is almost zero.

We often use a straw to drink liquid from a bottle. When we suck in air from the straw, the pressure of air inside the straw reduces. The air pressure on the surface of the soft drink then becomes greater than air pressure inside the straw. This therefore pushes the liquid up in the straw. In a similar way ink is filled in a fountain pen and medicine is filled in a dropper or a syringe.

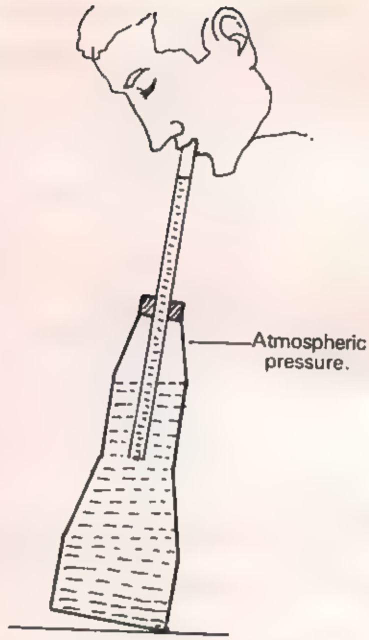


Fig. 2.17 Sucking reduces air pressure in the straw

EXERCISES

1. Choose the right words from the following and fill in the blanks.
decreases, increase, same, equals, volume, barometer, hydrometer, different
   - (i) Liquid pressure increases with ______ in the height of the liquid column.
   - (ii) A fish increases its ______ to come up in water.
   - (iii) Buoyant force ______ with decrease in density of the liquid.
   - (iv) At a point in a liquid, the pressure exerted is ______ in all directions.
   - (v) Buoyant force is ______ for different liquids.
   - (vi) Air pressure can be measured by a ______
   - (vii) Densities of liquids can be compared by a ______
   - (viii) The loss in weight of a body, immersed in a liquid ______ the weight of liquid displaced by the immersed part of the body.

2. Give reasons for the following:

(i) Balloons, filled with hydrogen gas rise up. After reaching a certain height they may burst.

(ii) An iron needle sinks in water but floats in mercury

(iii) Walls of a dam are made thicker at the bottom.

(iv) Water tanks in a city are constructed at heights greater than those of buildings.

(v) When a child learns swimming, he attaches an inflated rubber tube to his body.

(vi) The atmosphere exerts such a large force on our bodies but still we do not get crushed by it.

3 State True or False.

(i) Higher we go, greater is the air pressure.
(ii) If a piece of wood is immersed in water, and then released, it sinks.
(iii) Gases exert pressure in all directions.
(iv) Water exerts lateral pressure also.
(v) Liquid A has a density of 1.2 g/cc. Liquid B has a density of 1.15 g/cc. Liquid

A exerts greater buoyant force than Liquid B.

(vi) If a body is half immersed in water the buoyant force will be the same as when it is fully immersed.

4 State Archimedes' principle. __________

5. State Pascal's law and give an experiment to illustrate it.

6. Describe an experiment to show that air exerts pressure upwards as well as sideways. __________

7. A body weighs 500 g wt in air. When completely immersed in water, it weighs 340 g wt. What is the buoyant force acting on it? If the same body is partially immersed what will happen to the buoyant force? Give reasons for your answer. __________

8. In a small hydraulic press, the areas of two pistons are 1 sq cm and 10 sq cm respectively. Find the force required on the smaller piston to raise a load of 150 kg wt kept on the larger piston. __________

3

Simple Machines

We have learnt in Class 6 that a machine is a device which makes work easier for us. Let us now study some more details about the simple machines.

3.1 The Lever

The simplest form of lever consists of a rigid bar capable of turning about a fixed support called the **fulcrum.**

Let a load of 10 kg wt placed at one end of the bar be balanced by applying an effort of 2 kg wt at the other end of the bar. Let the load be placed at a distance of 1m from the fulcrum and the effort be applied at a distance of 5m from the fulcrum. The distance of load from the fulcrum is called **load arm** while the distance of effort from the fulcrum is called the **effort arm.** In the above example

load arm = 1m
effort arm = 5m

When the lever is balanced you will always find that,

Effort × Effort arm = Load × Load arm
2 kg wt × 5 m = 10 kg wt × 1m
i.e. 10 kg wt m = 10 kg wt m

This is the **principle of levers** and is applicable to any type of lever.

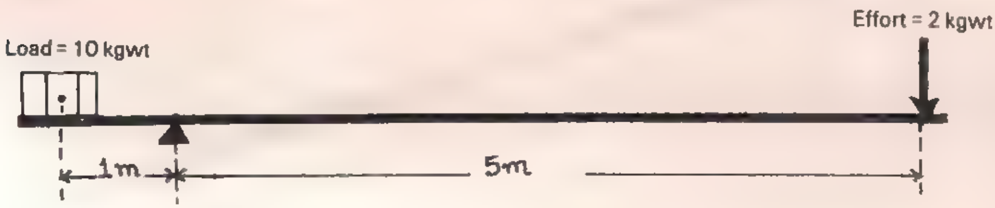


Fig. 3.1 Principle of lever.

Mechanical Advantage

The number of times a machine can multiply a force is called the **mechanical advantage (MA).** It is calculated by the ratio of load overcome to the effort applied. Thus

$$MA = \frac{\text{Load}}{\text{Effort}}$$

In the above example of crowbar

$$MA = \frac{10 \text{ kg wt}}{2 \text{ kg wt}} = 5$$

We also find that

$$\frac{\text{Effort arm}}{\text{Load arm}} = \frac{5\text{m}}{1\text{m}} = 5$$

Thus M A is also given by

$$MA = \frac{\text{Effort arm}}{\text{Load arm}}$$

By applying the principle of levers we can find out M A of any type of lever.

Work done and Efficiency

In the lever example, the effort arm is five times larger than the load arm. Suppose the lever moves from position A to position B (Fig. 3.2). It can be seen in the figure that the effort moves a greater distance than the load. Notice therefore that although we have used a small effort to lift a large load, the effort has moved a larger distance than the load.

Thus *if a machine helps us gain in force, it makes us lose in distance.* In fact we will find that in any machine.

Input work = Output work

or Work done by effort = Work done by load

i.e. Effort × Distance moved by effort = Load × Distance moved by load

$$\text{or} \quad \frac{\text{Load}}{\text{Effort}} = \frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$$

This result is, however, true only if there is no friction. In practice, there is always some friction present between two moving parts of a machine. Some energy is always wasted to overcome friction. Hence output work is always less than the input work. The *ratio of output work to input work is called the* **efficiency** of the machine. It is expressed as a percentage

$$\text{Efficiency} = \frac{\text{Output work}}{\text{Input work}} \times 100$$

In practice, efficiency of a machine is always less than 100%.

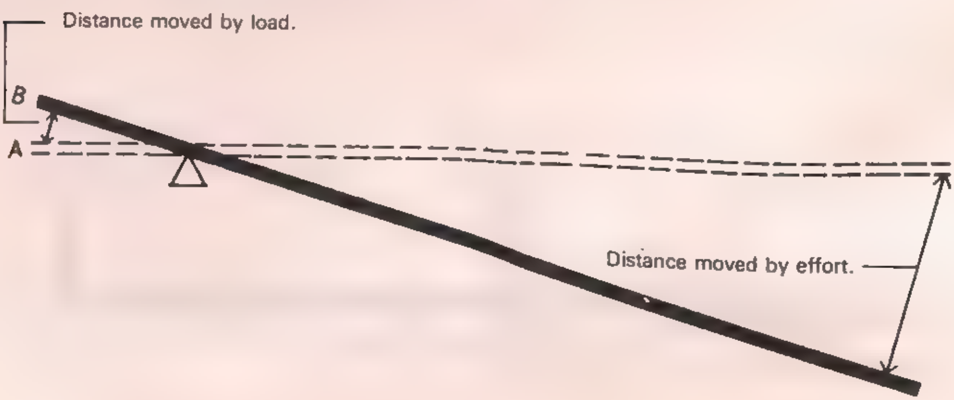


Fig. 3.2 If we gain in force we lose in distance.

Lever of First Type (Fig. 3.3)

You know that in this type of lever, the fulcrum is between the load and effort. As is clear from Fig. 3.3, the mechanical advantage is
less than 1 if effort arm < load arm
equal to 1 if effort arm = load arm
greater than 1 if effort arm > load arm

Lever of Second Type (Fig. 3.4)

In this type of lever the load is in between the fulcrum and effort. Here the effort arm is always bigger than the load arm. Thus a greater load is overcome by using a smaller effort. The mechanical advantage is always greater than 1.

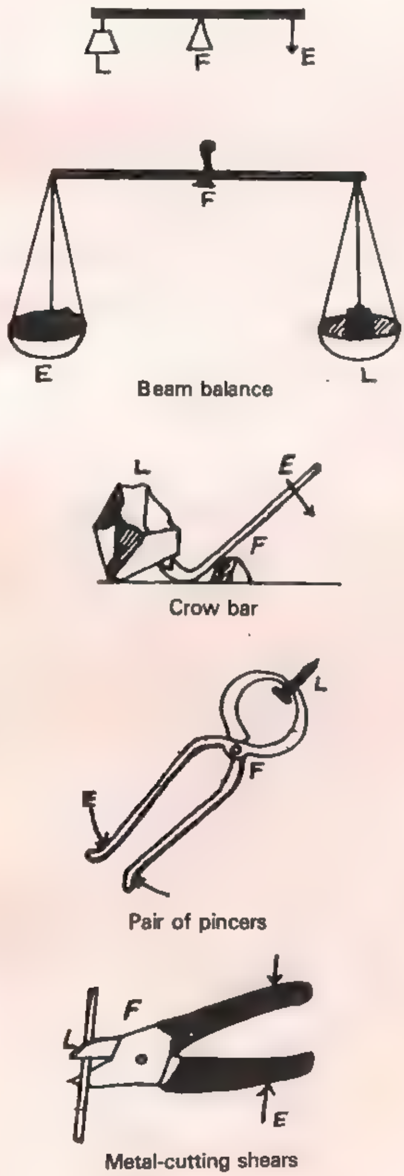


Fig. 3.3 Levers of first type

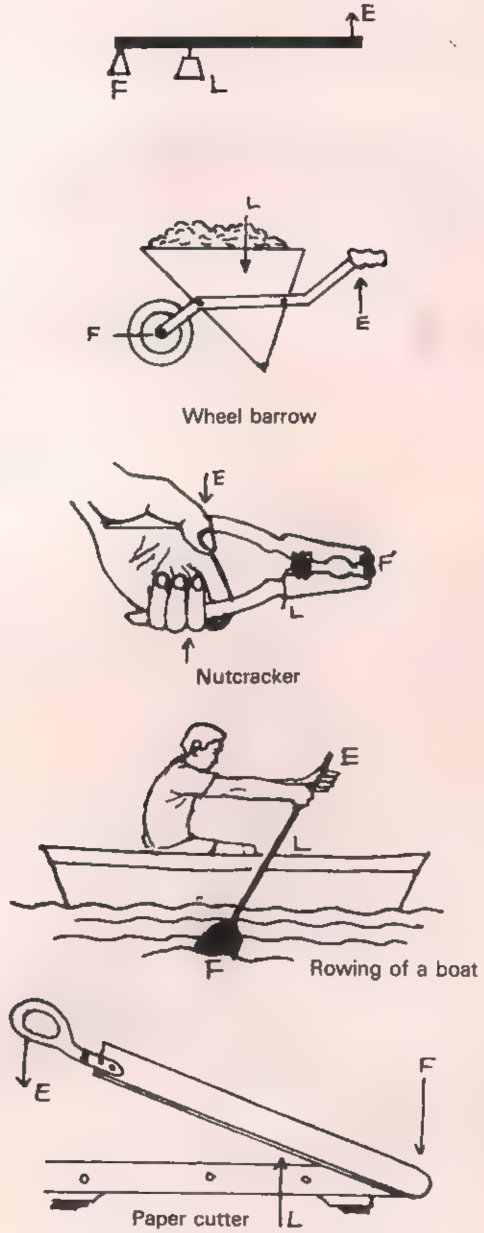


Fig. 3.4 Levers of second type.

Lever of Third Type (Fig. 3.5)

Here the effort is applied between the load overcome and the fulcrum. The load arm is always longer than the effort arm. Thus, in the lever of third type, a greater effort is needed to overcome a small load.

The mechanical advantage is always less than 1. Notice that in this case the load moves a greater distance than the effort. Thus, though we lose in force, we gain in distance.

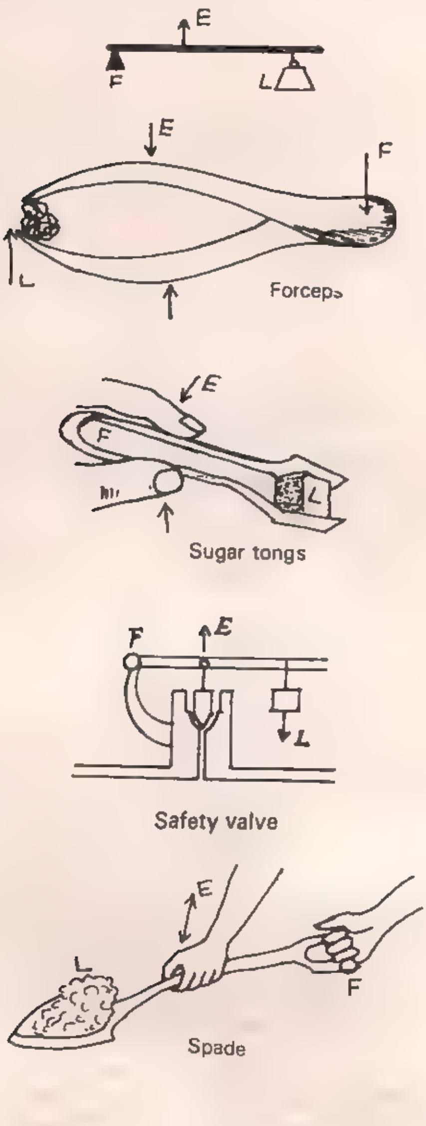


Fig. 3.5 Levers of third type.

3.2 Pulley

In a pulley, the load is attached to one end of a rope passing over the pulley. The effort is applied at the other end of the rope. If we attach a spring balance to this end of the rope to measure the effort, we will find that effort is equal to the load. We do not gain in force i.e. M A = 1. When the load is lifted, the rope on the side of the load is shortened by the same length as the rope on the effort end is lengthened. The distance moved by the effort is therefore the same as the distance moved by the load. Thus we do not gain in distance also.

The only advantage of the pulley is that *we can apply force in a convenient direction.* It would be extremely difficult to directly pull a bucket full of water from a well. This, however, becomes easy when a pulley is used. In this case the pulley helps us by enabling us to apply the force in the downward direction.

The work done by effort = effort × distance moved by effort

The work done by load
= load × distance moved by load

Since effort and load are equal and distance moved by effort and load are also equal, so work done by effort = work done by load. As stated in the case of lever this is true when their is no friction.In the presence of friction work done by the effort will be less than the work done by the load.

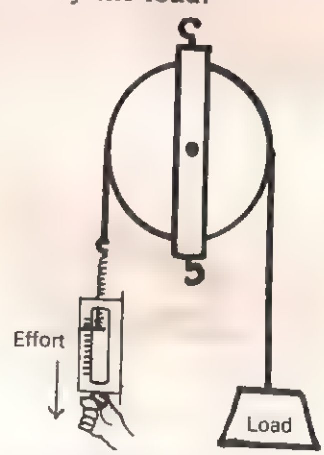


Fig. 3.6 With the help of a pulley we can apply force in any convenient direction.

3.3 Inclined Plane

You have learnt that we need a smaller effort to push a heavy load up an inclined plane. Thus using an inclined plane we gain in force. Hence M A > 1.

Fig. 3.7 The inclined plane.

3.4 Screw Jack

In a screw jack mechanical advantage is much greater than 1. It therefore enables us to raise heavy vehicles. Observe someone using a screw jack to lift a car to repair a puncture. You will notice that the distance the hand moves is much larger than the distance the car moves up. The gain in force is very large and the loss in distance is equally large.

Fig. 3.8 The screw jack.

EXERCISES

1 State the principle of levers. ____________________

____

2. (i) What do you understand by mechanical advantage? ____________________

____

____

____

(ii) How can you measure the mechanical advantage of a pulley? ____________________

____

____

____

3. (i) Discuss the mechanical advantage of the three types of levers. ____________________

____

____

____

____

____

(ii) In a lever if effort arm = 15 m, load arm = 2.5 m, find the M A. ________

4. What is meant by efficiency of a machine? Can a machine have 100% efficiency? Give reasons. ________

5. In a lever of third type we lose in force but gain in distance. Explain. ________

6. State true or false.
   (i) In a machine, we gain in work.
   (ii) Efficiency of an ideal machine is 100%.
   (iii) Force is gained in a pulley.
   (iv) The mechanical advantage of the second type of lever is always less than one.
   (v) The M A of a lever is 1.2. It can be the first, second or third type of lever.
   (vi) In a machine if we gain in force we need not lose in distance.

7. Fill in the blanks with suitable words.
   (i) The mechanical advantage of the first type of lever is always ________ one. (greater than, less than, equal to)
   (ii) In the third type of lever effort arm is ________ than the load arm. (longer, shorter)
   (iii) In a machine, input work is ________ output work. (greater than, less than, equal to)
   (iv) The mechancial advantage of a pulley is ________ one. (greater than, less than, equal to)

8. An effort of 25 kg wt is required to push a load of 100 kg wt up an inclined plane. Find the M A.. ____

____

____

9. A bucket of 20 kg wt is to be pulled out of a well with the help of a pulley. How much is the effort required? Assume that there is no friction. ________________________

____

10. A boy weighing 50 kg wt sits at a distance of 1m from the fulcrum of a see-saw. Where should a boy of 20 kg wt sit in order to balance the see-saw? ________________

____

____

____

4

Heat

In winters we sit in the sun or near a heater to get warmth. We use heat obtained from fuels to cook our food. In summers however, when the atmosphere becomes very hot we use fans, coolers and air conditioners to avoid heat.

Let us study the sources and some effects of heat in this chapter.

4.1 Sources of Heat

(a) *The sun* is the main and free source of heat. This heat evaporates water from ponds and lakes and converts it into water vapour. Plants use this heat to prepare their food. In solar heaters the sun's heat is used to warm water. No life is possible without the sun's heat.

(b) *The fuels:* Heat is produced by burning wood, coal, kerosene, petrol, cooking gas and other fuels. The heat produced by burning fuel is used to drive engines, to run cars, to generate electricity at thermal power stations and to cook food.

(c) *Electricity:* An electric current passed through the filament of a heater or toaster or electric iron makes it hot.

(d) *Friction:* When we rub our hands they become warm. When wood is cut by a saw, the saw becomes warm. The work done to overcome friction is converted into heat.

4.2 Heat is a Form of Energy

Activity 1: Weigh a small metallic rod. Heat it over a flame for some time, and weigh it again. We find that its weight remains the same as when it was cold. This shows that heat is not matter as it has no weight.

Activity 2: Take a test tube filled half with water. Close its mouth with a cork. Heat the test tube for some time. You will find that the cork is blown off. What does it show? It shows that heat is a form of energy. Due to this energy, work is done to push the cork.

Steam has a lot of heat energy. A steam engine converts this heat energy into mechanical energy to pull a train.

4.3 Temperature

When we touch a hot object our hand becomes warm because heat flows from the object to our hand. We say that the object is at a higher **temperature** than our hand. If we touch a cube of ice our hand feels cold because heat flows from our hand to the ice. We say that ice is at a lower **temperature** than our hand.

This suggests that *temperature is the degree of hotness or coldness of a body,* and that heat always flows from a body at higher temperature

to a body at lower temperature.

Molecules of a body are always in constant motion. When a body is heated, its molecules move faster. Thus their energy is increased and this makes the body hot.

4.4 Thermal Expansion of Solids

Activity 3: Take an iron ball and a ring such that the ball just passes through the ring as shown in Fig 4.1a.

Now heat the ball. You will find that the ball does not pass through the ring (Fig. 4.1b). Why is this so? When the ball is heated, it expands and its size (diameter) increases. After some time when the ball cools, it will again pass through the ring. This shows that solids expand on heating and contract on cooling.

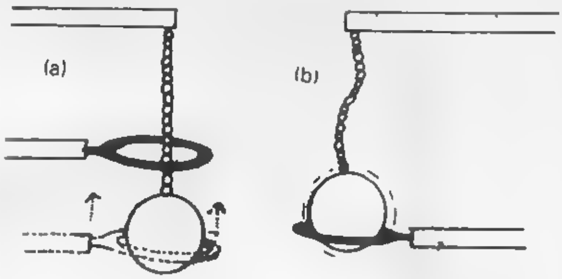


Fig. 4.1 The ball and ring experiment to show that solids expand on heating

A little space is always left between joints of two rails to allow space for expansion during summers (Fig. 4.2a). If the space is not left, the rails would bend on expansion. It is due to expansion that telephone and telegraphic wires sag during summers.

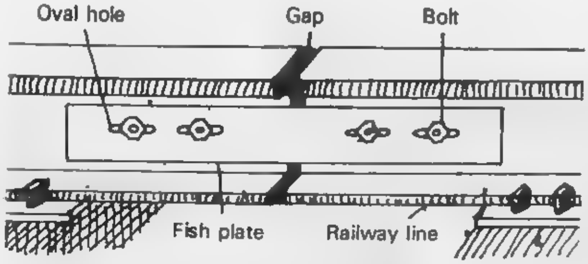


Fig. 4.2 (a) Gap left between railway lines to allow for expansion.

In big steel bridges, one end of the bridge rests over rollers to allow for expansion of the bridge (Fig. 4.2b).

The Bimetallic Strip

Different solids expand by different amounts, e.g. brass expands more than iron. This property is used in constructing a bimetallic strip which bends on heating. It consists of two strips of brass and iron riveted together (Fig. 4.3). If it is heated it bends due to unequal expansions of brass and iron. If cooled it bends in the opposite direction.

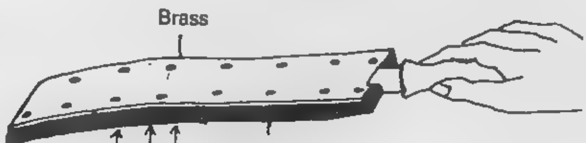


Fig. 4.3 A bimetallic strip bends on heating.

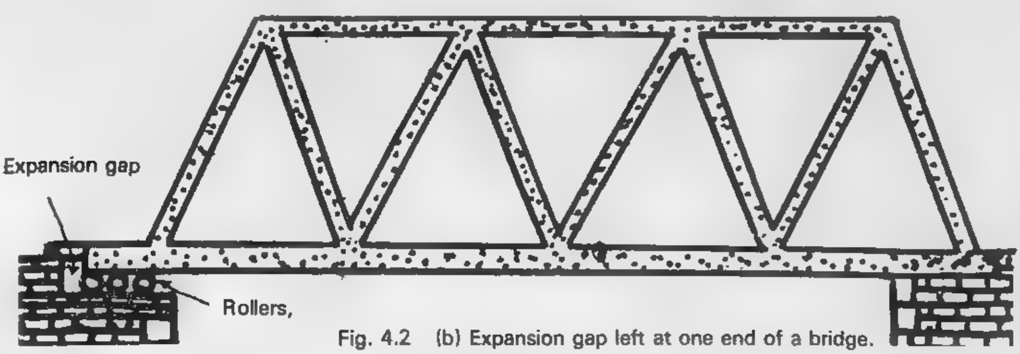


Fig. 4.2 (b) Expansion gap left at one end of a bridge.

The bimetallic strip is used to construct fire alarms and to control temperature in an electric iron or oven (Fig. 4.4).

A fire alarm consists of a bimetallic strip that acts as an on-off switch in an electric circuit containing an electric bell. Whenever there is a fire, the temperature rises and the bimetallic strip in the fire alarm bends. This causes the circuit of the electric bell to be completed. The bell rings and gives the alarm. The same principle is used to control temperature. An electric iron or oven contains a bimetallic strip which bends and breaks the electric circuit when the desired temperature is reached. When the temperature comes down again, the bending decreases and the circuit is again completed.

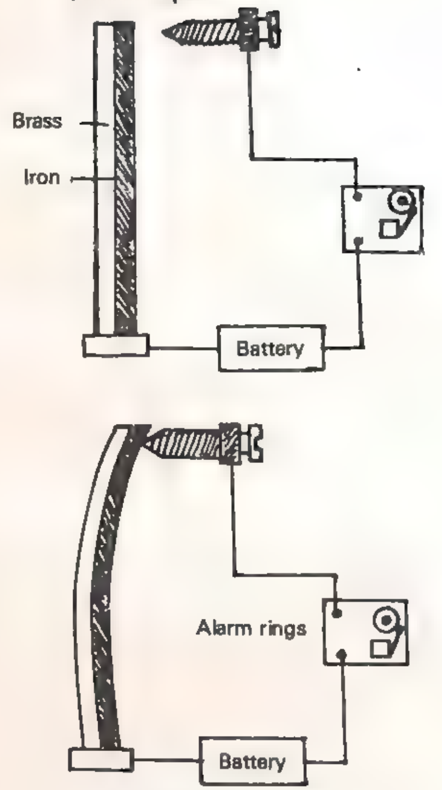


Fig. 4.4 A fire alarm using a bimetallic strip.

4.5 Expansion of Liquids

Activity 4: Take a flask completely filled with coloured water. Close its mouth with a cork having one hole. Pass a narrow glass tube through the cork. Attach a scale to the glass tube to note the level of water (Fig. 4.5). Heat the flask for some time. What do you observe? First the level of water falls a little due to expansion of the tube, then it starts rising, show-

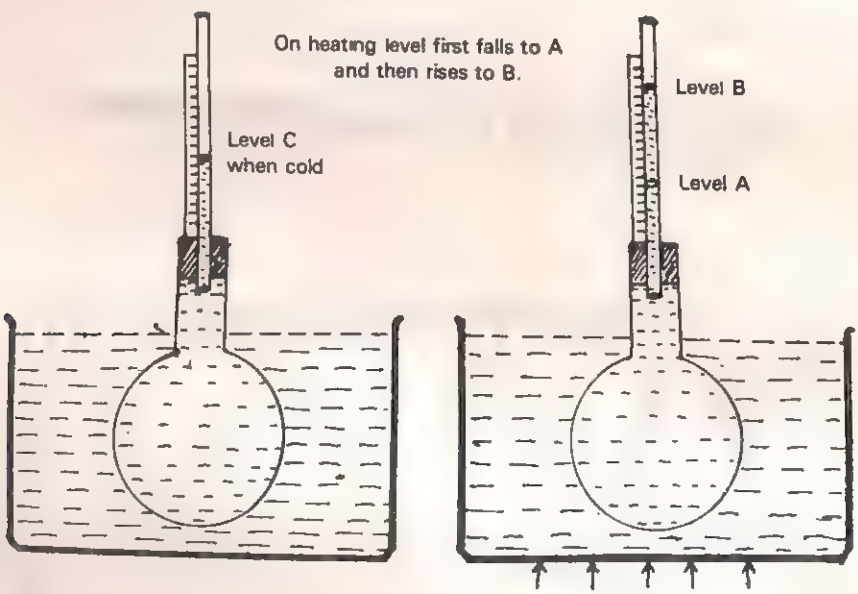


Fig. 4.5 Liquids expand on heating. Water level rises on heating.

ing that water expands on heating. If the tube is allowed to cool, the level falls back as the water contracts on cooling.

Different liquids expand by different extents on heating.

4.6 Expansion of Gases

Activity 5: Take a flask with a tight fitting cork having a long narrow glass tube. Support the flask as shown in Fig. 4.6, and dip the end of the tube in a beaker of water. Heat the flask with a candle flame. You will observe that air bubbles come out of the tube. This shows that air in the flask expands on heating. If the flask is now cooled, the water rises up in the tube showing that air contracts on cooling.

Expansion of gases is very much more than that of liquids and solids. Solids expand the least on heating.

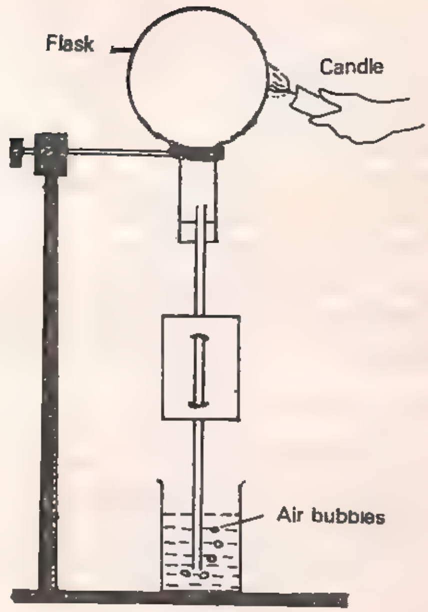


Fig. 4.6 Gases expand on heating.

4.7 Measurement of Temperature

By touching a body we can roughly find out how hot or cold it is. But our sense of touch is not a reliable method of measuring temperature. To find the degree of hotness of a body we use a thermometer.

A thermometer is based on the principle that materials expand on heating and contract on cooling. The amount of expansion or contraction gives us a measure of the temperature.

Activity 6: You can yourself make a thermometer by using the apparatus shown in Fig. 4.7. Heat the flask and then cool it so that water rises in the tube. Attach a scale marked on paper, to the tube. Warm the flask by holding it in your hands. You will notice that the level of water goes down. Cool the flask by keeping ice over it. The level of water goes up. The extent by which the level of water goes up or down indicates the temperature. To actually

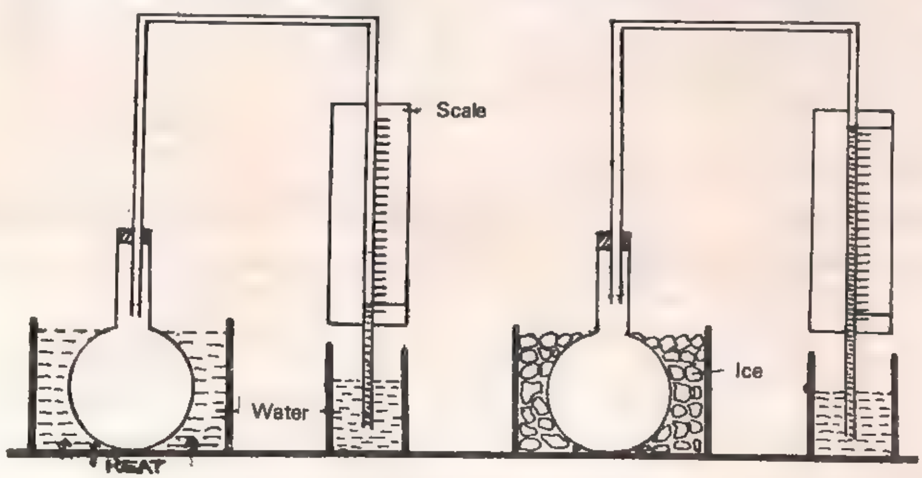


Fig. 4.7 A home made gas thermometer.

measure temperature you have to calibrate your thermometer against a standard thermometer.

There are different types of thermometers. Most thermometers use mercury or alcohol as the liquid which expands on heating. The liquid is partly contained in a bulb and partly in a narrow stem with the scale marked on it. The stem is sealed off after evacuating air from it. As the temperature rises, the liquid level in the stem rises, and the temperature can be read on the scale.

The Fixed Points

To standardise the temperature scale we fix two standard temperatures which do not vary. These are:

(i) The **lower fixed point** which is the temperature at which pure ice melts at sea level.

(ii) The **upper fixed point** which is the temperature at which pure water boils at sea level.

The Temperature Scales

The most commonly used temperature scales are the **Celsius** and the **Fahrenheit** scales.

(i) *The Celsius scale* (Fig 4.8a): Temperature is measured in **degree Celsius (°C).** The lower fixed point is taken as 0°C and the upper fixed point as 100°C. The normal temperature of the human body is 37°C.

(ii) *The Fahrenheit scale* (Fig. 4.8b): Temperature is measured in **degree Fahrenheit** (°F). The lower fixed point is taken as 32°F and the upper fixed point as 212°F. The normal temperature of the human body is 98.6°F.

Interconversion of Scales

If a temperature in degree centigrade is to be converted to degree Fahrenheit or vice versa, we use the formula

$$\frac{C}{100} = \frac{F - 32}{180} \text{ or } C = \frac{5}{9}(F - 32)$$

C = temperature in °C

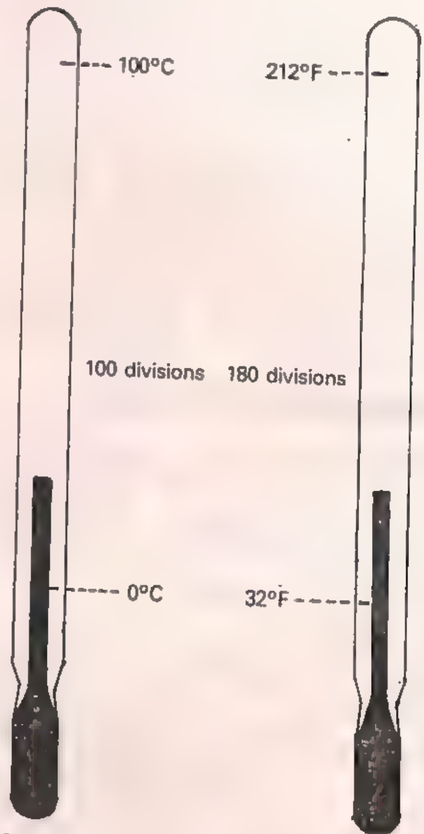
F = corresponding temperature in °F

Example: Convert 77°F into °C

$$C = \frac{5}{9}(77 - 32)$$

$$= \frac{5}{9} \times 45$$

$$= 25\,°C$$



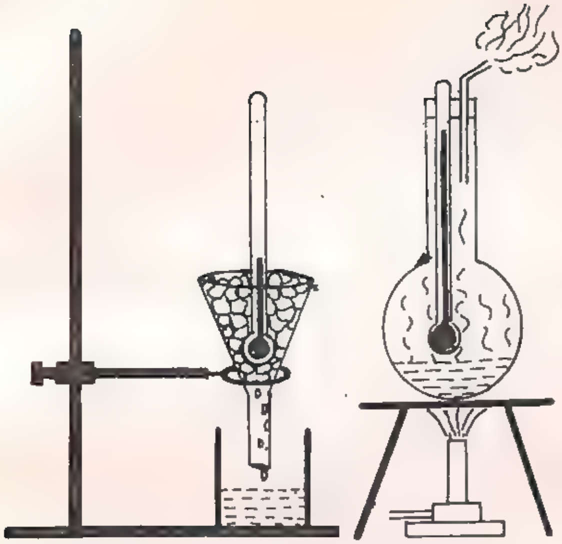
(a) Celsius scale (b) Fahrenheit scale

Fig. 4.8 The temperature scales.

Marking the Upper and Lower Fixed Points

Melting ice is taken in a funnel and the bulb of the thermometer is inserted in it (Fig. 4.9a). After some time the liquid level becomes constant. This level is marked as 0°C or 32°F.

Water is boiled in a flask and the thermometer is suspended in the flask so that it is just above the water level (Fig. 4.9b). It then measures the temperature of steam above the



(a) Lower fixed point. (b) Upper fixed point

Fig. 4.9 Marking the fixed points of a thermometer.

water. The liquid level rises and becomes constant at a level which is marked as 100°C or 212°F.

The distance between the two fixed points is divided into 100 equal parts in the Celsius scale and 180 equal parts in the Fahrenheit scale. Each division is a degree Celsius or Fahrenheit.

Clinical Thermometer

The thermometer which you use to measure body temperature is called the **clinical** or **doctors' thermometer**. It is marked from 35°C to 43°C (or 95°F to 110°F) and has a mark at the normal body temperature (37°C or 98.6°F). The temperature range is chosen to be 35°C to 43°C because no human being can live if his body temperature crosses these limits.

What will happen to the thermometer if it is washed with boiling water? Since the temperature of boiling water is much above 43°C, the force of expanding mercury will break the thermometer.

If you look carefully you will notice a slight kink at the place where the stem joins the bulb in a clinical thermometer (Fig. 4.10). When the thermometer is removed from the body, the mercury contracts. However, the mercury thread breaks at the kink and the level in the thread does not fall. The temperature can therefore be read even after some time. When you want to use the thermometer again, you have to jerk it so that the mercury in the thread goes back into the bulb.

Thermometer Liquids

Mercury is the most commonly used thermometer liquid. It is silver coloured and can therefore be easily seen in the stem. It does not wet glass and therefore gives accurate results.

However, mercury solidifies at -39°C and hence cannot be used below this temperature. For measuring very low temperatures, therefore, alcohol thermometers are used. Alcohol freezes at -117°C. Alcohol also has the advantage of greater expansion which makes alcohol thermometers more sensitive. However, alcohol wets glass and can also not be used for high temperatures as it boils at 78°C. Since alcohol is colourless it has to be coloured (generally red) to make the reading easier.

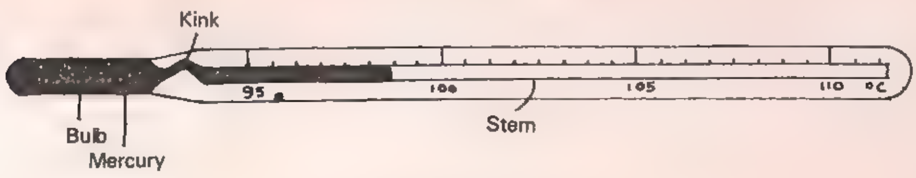


Fig. 4.10 Clinical thermometer.

EXERCISES

1. How would you show that heat is a form of energy?

2. Energy is needed to evaporate water from ponds and lakes. How is this energy provided?

3. What do you mean by temperature of a body?

4. (i) Why are lower and upper fixed points necessary to fix a thermometer scale?

   (ii) Which are the two most commonly used scales? Mention the lower and upper fixed points in each.

5. What will be the shape of the following bimetallic strip when it is (i) heated (ii) cooled?
   (i) Aluminium/Brass (ii) Lead/Iron
   Hint: Aluminium expands more than Brass. Iron expands less than Lead.

6. If we have a solid thermometer, a liquid thermometer and a gas thermometer, which is expected to be the most sensitive? Why?

7. Convert
   (i) 45°C into °F

(ii) 68°F into °C ______________________________

____

____

8. What would happen if there was no kink in the stem of the clinical thermometer?

____

____

____

____

9. Which liquid would you recommend in the thermometers used for the following? Give reasons.
   (i) To measure temperature in a cold country where temperature varies from −50°C to +10°C.
   (ii) To measure temperatures in the range 100 − 150°C.

10. Give reasons for the following:
   (i) A thick glass cracks when boiling water is poured in it. ______________________________

____

____

____

   (ii) When a carpenter uses a saw, it becomes hot. ______________________________

____

____

____

   (iii) Iron tyres are heated before they are fixed to cart wheels. ______________________________

____

____

____

11 Fill in the blanks.
   (i) Normal temperature of the human body is ______________ °C.
   (ii) In a bimetallic strip the expansion of two metals is ______________. (same, different)
   (iii) Heat flows from a body with ______________ temperature to a body with ______________ temperature.
   (iv) Heat is a from of ______________ (matter, energy).
   (v) A thermometer uses the property of ______________ on heating.

5

Light

If you enter a dark room you cannot see anything. Switch on a torch and the objects towards which the torch is pointed become clearly visible. A torch, as you know, emits light when it is switched on. It is a luminous object. Some other luminous objects are the sun, the stars, a lighted candle or a glowing electric bulb. When light from a luminous object falls on our eyes, we can see the object. When light from a luminous object falls on a table kept in a dark room the table also becomes visible. This happens because the table reflects light falling on it to our eyes. Thus non-luminous objects such as table, chair, pen, book etc. become visible when light from a luminous object falls on them and is reflected to our eyes Fig. 5.1.

5.1 Transparent, Translucent and Opaque Objects

Activity 1: Switch on a torch and keep it on a table. Keep a glass block between your eyes and the torch. You can see the torch, its bulb as well as the table on which it is kept. Such objects through which light can pass easily and through which we can clearly see are **transparent** objects. Air is also transparent.

Now keep a piece of 'frosted' glass, such as the one used in bathroom windows, between your eyes and the torch. You can now faintly see the glow of the torch, but the torch itself, or the table, are not visible. Such objects through which light can pass partially but through which we cannot see clearly are called **translucent** objects. Tracing paper is also a translucent object.

Next keep a piece of cardboard between your eyes and the torch. Neither the glow of the torch, nor the torch or table are visible through the cardboard. Such an object through which light cannot pass at all are called **opaque** objects. Metals, wood etc. are opaque.

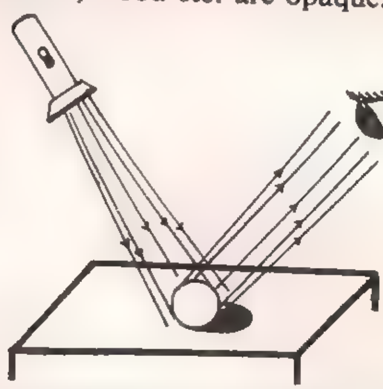


Fig. 5.1 Non-luminous objects become visible when light from luminous objects falls on them and is reflected to our eyes.

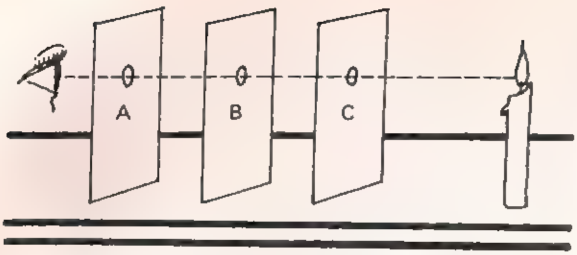


Fig. 5.2 Light travels in straight lines.

5.2 Rectilinear Propagation of Light

While seeing a film in a cinema hall you may have noticed that the light from the projector appears to go in a straight line to the screen. You must realise however, that light itself is not visible. Only the objects on which it falls become visible. In a cinema hall what you see is not light itself but innumerable dust particles in the path of light which become visible when light falls on them. Let us perform an experiment to see if light actually travels in a straight line.

Activity 2: Take three pieces of cardboard. Use supports to make them stand vertically on the table. Make holes A, B and C in each of them such that the holes are in one straight line. Now place a candle near hole A, at the same level. See from hole C. You will notice that the flame of the candle is visible (Fig. 5.2).

Now displace one of the cardboards from its position so that the holes are no longer in a straight line. Can you see the flame now? You will find that it is not visible. Adjust the cardboards so that the flame is visible again. You will notice that the three holes are again in one straight line. This shows that light from the candle travels in a straight line from the candle to your eyes.

5.3 Shadows

Shadows are formed because light travels in straight lines. If we keep an opaque object in the path of light, light cannot go through it and can also not go around it. Therefore light gets stopped by the object. Let us see what happens because of this stoppage of light.

Shadow Formed by a Point Source

Activity 3: Cover the front glass of a powerful torch with black tape and make a small hole in the centre. This will help you get a small source or **point source** of light. Switch on the torch in a dark room and point it towards a wall. Place a cardboard piece in front of the torch. What do you observe on the wall? You will notice a dark patch or shadow of the same shape as the cardboard piece on the wall. Move the cardboard piece towards the torch. The shadow will become bigger. Move it away from the torch, the shadow will become smaller. Figure 5.3 explains why this happens on the basis of rectilinear propagation of light.

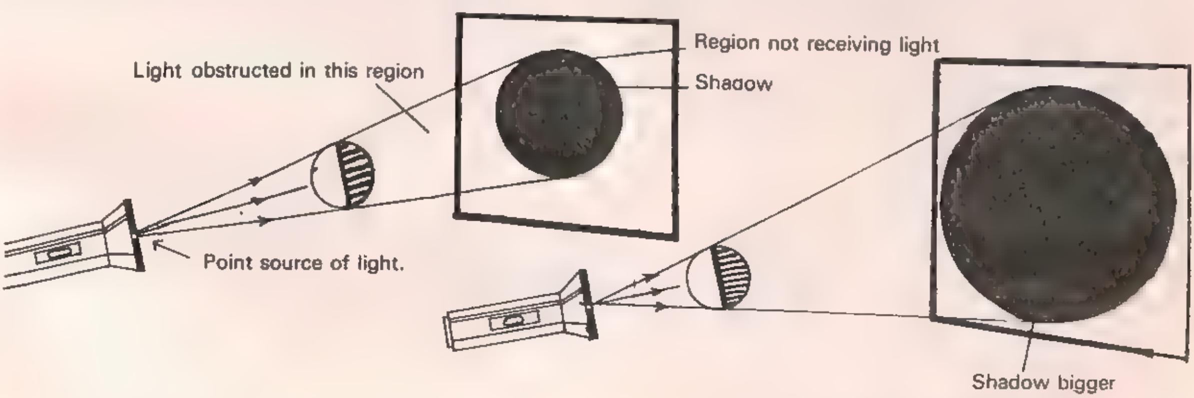
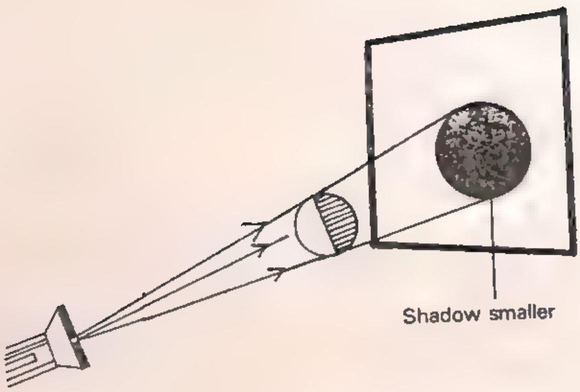


Fig. 5.3 (a) Shadow formed by a point source of light.

(b) The shadow becomes bigger when the object is moved towards the source of light.



(c) The shadow becomes smaller when the object is moved away from the source of light.

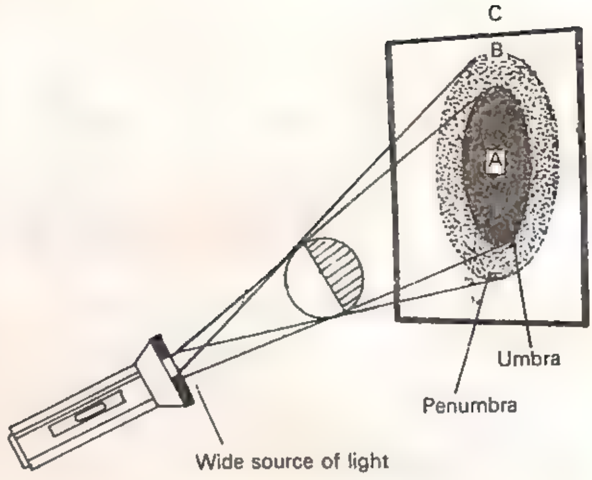


Fig. 5.4 Shadow formed by a wide source of light contains two regions—umbra and penumbra.

Shadow Formed by a Wide Source of Light

Activity 4: A torch, with the front glass not covered can be used as a wide source of light. Form the shadow of the cardboard piece using the wide source of light. Do you notice a difference? The shadow will have two portions—one dark portion in the centre called the **umbra** and another faint part on the outside called the **penumbra** (Fig. 5.4).

Ask a friend to hold the torch for you and look at the torch from positions A, B and C. From A, you will not be able to see the torch at all. Thus A receives no light. From B you will be able to see the upper part of the torch. Thus light is partially cut off at B. From C you can see the full torch.

Thus we notice that the umbra receives no light at all and the penumbra receives light from a part of the source.

5.4 Eclipses

Solar Eclipse

You have read about solar and lunar eclipses in Class 6. A solar eclipse occurs when the Moon comes in between the Sun and the Earth and a shadow of the Moon is formed on the Earth (Fig. 5.5). Here the Sun acts as the source of light, the Moon as the obstacle and the Earth as the screen. If you are in the umbral region on the Earth you will not see the Sun at all, and will experience total solar eclipse. In the penumbra the eclipse will be partial.

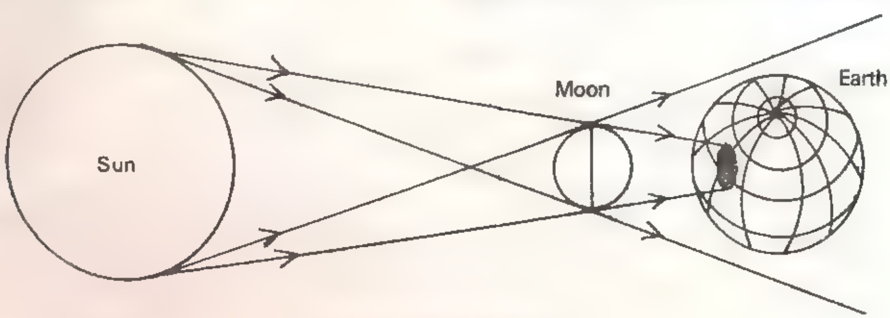
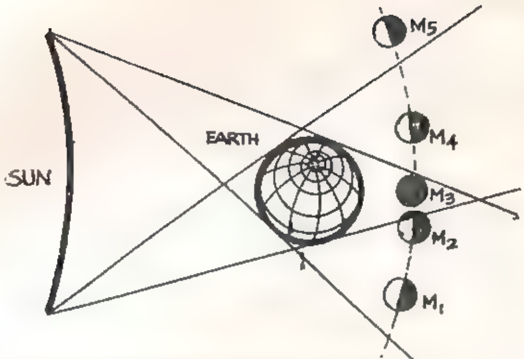


Fig. 5.5 Solar eclipse.



M_3—Total eclipse in this (umbral) region.
M_1 & M_4—Partial eclipse in this (penumbral) region.
M_5—Moon is visible.

Fig. 5.6 Lunar eclipse.

Lunar Eclipse

A lunar eclipse occurs when the shadow of the Earth falls on the Moon. Here the Sun acts as a source, the Earth as the obstacle and the Moon as the screen. If the Moon is in the umbral region of the Earth's shadow it is totally dark and we observe total lunar eclipse. The eclipse is partial when the Moon is in the penumbra,Fig. 5.6.

5.5 The Pin Hole Camera

An interesting application of the principle of rectilinear propagation of light is the pin hole camera. In this, an image of an object is formed on a screen.

Activity 5: Take a cardboard box and cut out one of its ends. Paste tracing paper on that end. Make a small hole at the centre on the other side. Your pin hole camera is ready. Point the pin hole towards a well lighted object such as a tree. You will find that an inverted image of the tree will be formed on the tracing paper. For best results keep the camera in a room where there is less light. Fig. 5.7 shows very clearly how the image is formed because of rectilinear propagation of light.

Every point on the object sends out light rays in all directions. But only a very narrow beam passes through the pin hole. Light from the point A after passing through the pin hole falls at A′. Light from point B falls at B′. Similarly light from all points on AB will produce corresponding image points between A′ and B′ and we get on the screen an inverted image of the object. It can easily be seen that as the object is moved towards the hole, the size of the image increases. If you measure the heights of the object and image and their distances from the pin hole you will find that

$$\frac{\text{Height of image}}{\text{Height of object}} = \frac{\text{Distance of image from hole}}{\text{Distance of object from hole}}$$

If the tracing paper is replaced by a photographic film, we can actually take photographs with the camera. However, the light being received on the screen is so small that it is difficult to obtain a bright picture.

Fig. 5.7 The pin hole camera.

EXERCISES

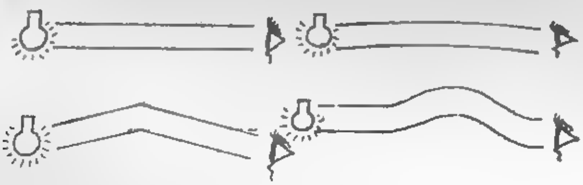
1. What is the difference between a luminous and a non-luminous object? Explain with examples. ______

2. What is the difference between transparent and translucent objects? Explain with examples. ______

3. Can a transparent object form an image? Why? ______

4. What will be the difference in the shadows formed by translucent and opaque objects? ______

5. In which of the following arrangements can you see the light bulb and why?



6. In a pin hole camera how would the image change if (i) the hole is made bigger? ______

(ii) the distance between the pin hole and screen is made smaller? ______

7. What is the essential difference between an image and a shadow? ______

8. Write True or False.
   (i) An electric bulb with its switch off is a luminous object.
   (ii) A firefly is a luminous object.
   (iii) We can only see an object if it emits light of its own.
   (iv) An image is formed because of stoppage of light by an opaque object.
   (v) Light can pass around small objects such as a grain of wheat.
   (vi) If a beam of light is passed through a perfectly dust free room, we can see it going through the room in a straight line.
   (vii) The penumbra is a region which receives light only from a portion of the source.
   (viii) If you are in the umbral region of a shadow you can faintly see the source of light.
   (ix) Eclipses occur due to formation of images.
   (x) An inverted shadow of an object is formed by a pin hole camera.

9. Fill in the blanks:
   (i) A ______ object becomes visible when light from a ______ object falls on it.
   (ii) We ______ (can/cannot) see through an opaque object.
   (iii) The shadow formed by a point source of light ______ (has/does not have) a penumbra.
   (iv) The shadow formed by a wide source of light ______ (has/does not have) a penumbra.
   (v) A lunar eclipse can only occur on a ______ (New Moon/Full Moon) day.
   (vi) A solar eclipse can only occur on a ______ (New Moon/Full Moon) day.

10. Draw diagrams to show formation of (i) Lunar eclipse (ii) Solar eclipse

6

Reflection of Light

When a ball is thrown on the ground or at a wall it bounces back. When light falls on an object some of it bounces back. This 'bouncing' back of light is known as **reflection.** In the case of a ball, the entire ball bounces back, but in the case of light, three things can happen.

(i) Part of the light may pass through the object if it is transparent or translucent.

(ii) Part of the light may be absorbed by the object.

(iii) Part of the light may be reflected by the object.

It is the reflected portion that enables us to see the object. In the case of a transparent object such as a glass sheet, the portion of light reflected back is very small while the portion passing through it is large. That is why we can see through glass but have difficulty in seeing a clean glass window pane.

The light falling on any surface is called the **incident** light. The portion reflected by the object is the **reflected** light, while the portion that goes through is the **transmitted** light.

6.1 Regular and Diffused Reflection

Activity 1: Hold a mirror in sunlight, facing the Sun and allow the reflected light to fall on a wall. It will form a bright area on the wall. As you change the position of the mirror the position of the bright area on the wall receiving sunlight also changes. In this case all the sunlight falling on the mirror is reflected in one direction only. This type of reflection from a smooth polished surface is called **regular reflection** (Fig. 6.1a). Now try to do the same with a flat piece of wood with a rough surface. You will find that no bright area can be obtained on the wall. In the case of a rough surface, light is not reflected in one direction only. It is scattered in all directions. This is known as **diffused** or **irregular reflection** (Fig. 6.1b).

6.2 Reflection by a Plane Mirror

A plane mirror is used by us every day for looking at our own image while combing our hair or washing our face. We can see our image in a mirror but not in a plain glass sheet or in a

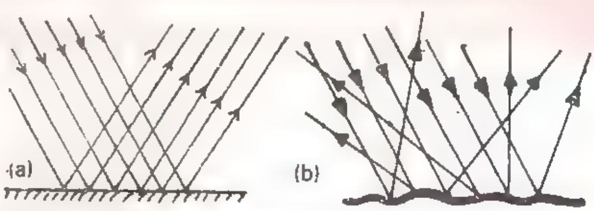


Fig. 6.1 (a) Regular reflection from a smooth surface.
(b) Irregular reflection from a rough surface.

piece of wood. Why? This is because most of the light falling on a mirror is reflected by it. Let us study how light is reflected and how an image is formed by a plane mirror

Activity 2: Keep a white sheet or paper on a table in a dark room. Place a narrow slit in front of a powerful torch kept on the white sheet to get a narrow beam of light. The path of the beam of light can be observed as it travels along the white paper and illuminates it. Let the beam fall on the plane mirror standing vertically on the white sheet (Fig. 6.2a). You will notice that the beam is reflected by the mirror in a particular direction. If you change the angle of the mirror the direction of the reflected beam also changes.

With the mirror in a particular position trace its outline. Mark two points A and B on the incident ray and two points C and D on the reflected ray. Join AB and DC and produce them to meet the mirror at O (Fig. 6.2b). Draw a line ON perpendicular to MP at O. AO is the incident ray, OD is the reflected ray. The point O where the two rays meet the mirror is known as the **point of incidence.** ON is the **normal** to the mirror at point O. ∠AON is known as the **angle of incidence,** and ∠NOD as the **angle of reflection.**

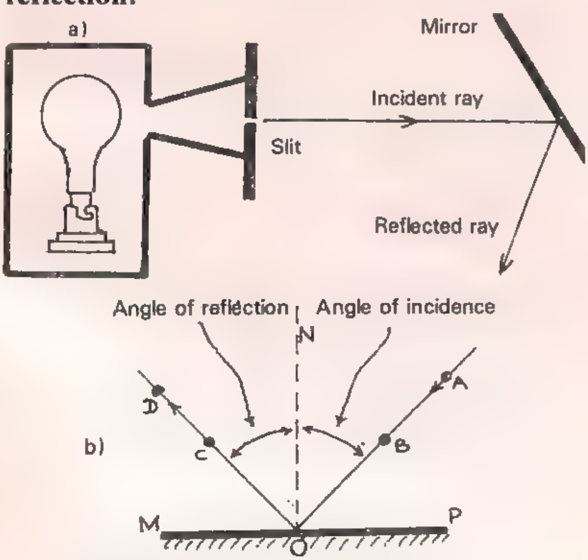


Fig. 6.2 Reflection in a plane mirror.

Measure ∠AON and ∠NOD. You will find that they are equal.

You can carry out the experiment for other positions of the mirror. In each case you will find that

Angle of incidence = Angle of reflection

This is known as the **first law of reflection.** Also notice that in the above experiment the incident ray, the reflected ray and the normal all lie in the plane of the paper. This firmly fixes the direction of the reflected ray and is known as the **second law of reflection.** *The incident ray, the reflected ray, and the normal at the point of incidence, all lie in the same plane.*

The above experiment is, however, very crude and cannot be expected to give accurate results. The beam of light is broad and the points A, B, C and D cannot be marked accurately. A more accurate experiment is as follows.

Activity 3: Fix a white sheet of paper on a drawing board. Make a plane mirror stand vertically on it. Mark the outline of the mirror.

To fix the position of the incident ray fix two pins A and B such that the line AB meets the mirror at an angle.

Now look at the reflection of the pins in the mirror and fix two pins C and D such that the pins C and D and the images of pins A and B are in one straight line. Then CD is the reflected ray (Fig 6.3).

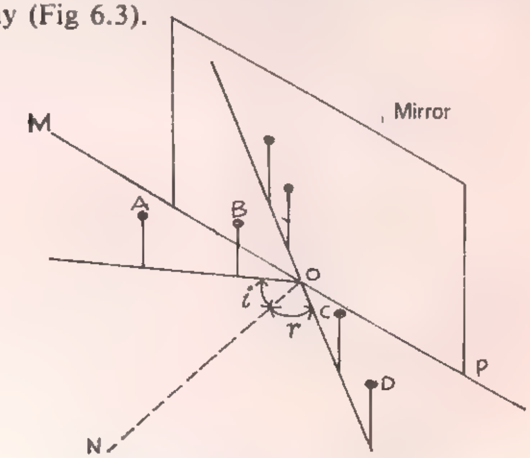


Fig. 6.3 Reflection in a plane mirror.

Remove the mirror and pins. Join AB and produce it to meet the mirror outline at O. Join DC and produce it. It should also meet the mirror outline at O. Draw the normal ON at O. Measure the angle of incidence i and the angle of reflection r (Fig. 6.3).

Carry out the experiment for different positions of the incident ray AB. You will find that in all cases

$$\angle i = \angle r$$

6.3 Image Formed by a Plane Mirror

Suppose O is a point source of light and OA, OB and OC are three rays incident on the plane mirror. Draw the reflected rays at A, B and C using the laws of reflection, and produce them backwards. What do you find? The rays meet at a point I behind the mirror (Fig. 6.4). If the mirror was not present, and the point source of light was at I instead of O we would have had rays IAD, IBE and IBF coming out from it. Thus the reflected rays of light appear to come from the point I. I is the image of point O in the mirror. If you hold a torch at O, you can see its image at I in the mirror.

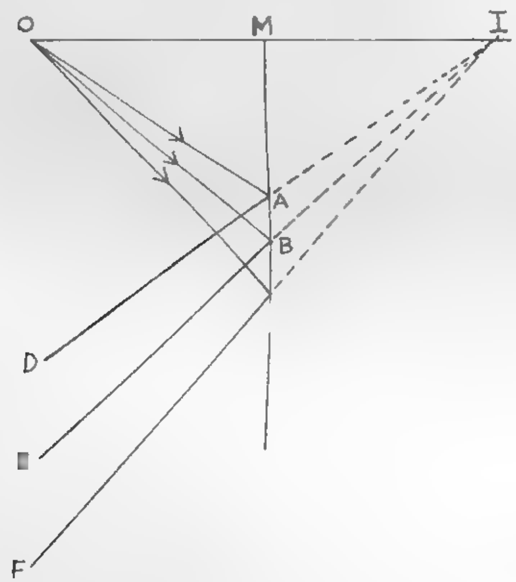


Fig. 6.4 Image formed by a plane mirror.

Location of Image

Activity 4: Set up the sheet of paper, drawing board and plane mirror as in Activity 3.

To locate the image we need at least two incident rays. Fix a pin at a point O. This is the object. Fix another pin at A such that OA is an incident ray. Fix pins C and D to locate the reflected ray (Fig. 6.5).

Similarly fix a pin B such that OB is an incident ray. Locate the reflected ray EF. Remove the mirror and pins. Join DC and FE and produce them backwards so that they meet at I. I is the image of O.

Join OI. Mark point X where it meets the mirror. Measure OX and XI and $\angle$OXP and $\angle$IXP. You will find that

$$OX = IX$$
$$\angle OXP = \angle IXP = 90°$$

Carry out the experiment with different positions of O and verify if this holds in all cases. You will find that it does. Thus the perpendicular distance of the image from the mirror is the same as the perpendicular distance of the object from the mirror. In other words: *The image is formed as much behind the mirror as the object is in front of it.*

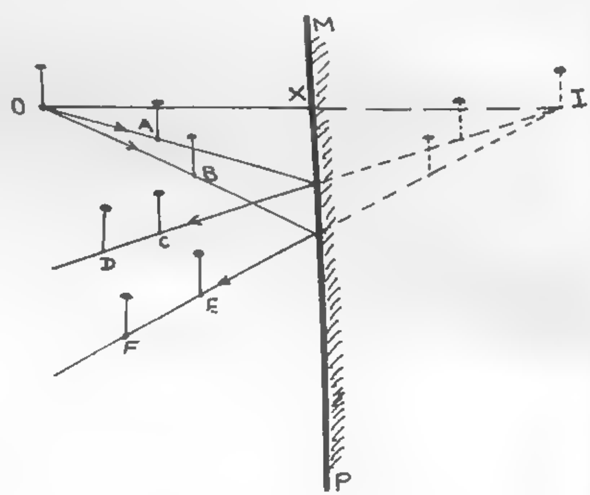


Fig. 6.5 Image formed by a plane mirror.

This means that if you stand 1m in front of a mirror, the image is 1m behind the mirror. If you move back 1m the image also moves back 1m. If you move ahead and touch your nose to the mirror, the image does the same.

Real and Virtual Images

You have learnt that images can be formed by a pin hole camera as well as by a mirror. Is there any difference between the two images? In the case of a pin hole camera the image is formed on a screen by light actually falling on it. You can even touch the image. In a mirror, however, light appears to come from the image and does not actually fall on it. The image cannot be received on a screen. While you know that the image is formed behind the mirror you cannot go at the back of the mirror and touch the image. The pin hole camera forms a **real image** whereas a plane mirror forms a **virtual image**.

Lateral Inversion

Activity 5: Stand in front of a plane mirror and raise your right hand. Which hand does the image raise? The image will raise its left hand. If your friend is standing next to you on your right in the image he will be standing to your left.

Thus the image in a mirror is inverted in a particular way. This type of inversion is known as **lateral inversion.**

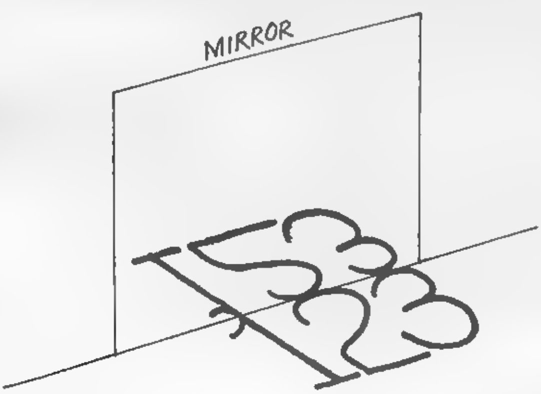


Fig. 6.6 Lateral inversion in a plane mirror.

In a pin hole camera the image is not of the same size as the object whereas in a plane mirror it is always of the same size.

Also, the image in a pin hole camera is inverted whereas the image in a plane mirror is upright.

Thus we find that the image formed by a plane mirror is

(i) Virtual
(ii) Upright
(iii) Same size as object
(iv) Laterally inverted
(v) As far behind the mirror as the object is in front of it.

6.4 Formation of Image by Inclined Plane Mirrors

Activity 6: Keep a burning candle on a plane mirror and hold another plane mirror at an angle to the first mirror. For various angles between the plane mirrors count the number of images formed. You will find that whereas for 90° only 3 images are formed, for 80°, 4 images are formed whereas for 60°, 5 images are formed.

Actually the image formed by one mirror acts as the object for the other mirror. Thus several images are formed by multiple reflections. In Fig. 6.7, I_1 is the image of I formed by mirror M_1 and I_2 is the image of I_1 formed by mirror M_2. Similarly I_3 is the image of I formed by M_2 and I_4 is the image of I_3 formed by M_1. Thus at this angle four images are formed.

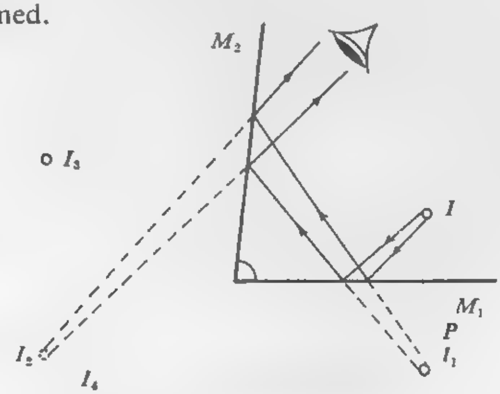


Fig. 6.7 Multiple images formed by inclined mirrors.

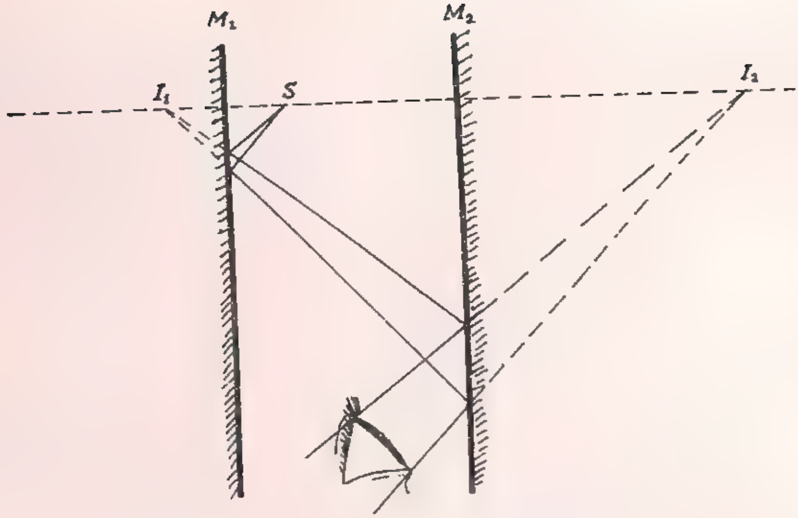


Fig. 6.8 Multiple images formed by parallel mirrors.

Images Formed by Parallel Mirrors

Activity 7: Keep the two mirrors M_1 and M_2 parallel to each other and the lighted candle in between the two. You will find an innumerable number of images. This is because the image of S formed by M_1 becomes the object for mirror M_2 and so on to produce a series of images. The successive images however become less bright.

6.5 Applications of Plane Mirror

Plane mirrors are used by us every day primarily to see ourselves. But plane mirrors also have other important uses. We will discuss two of them in detail.

Periscope

A periscope, in its simplest form, consists of two mirrors arranged parallel to each other so that they can be used to view objects over an obstacle. Fig 6.9 shows the periscope of a submarine under water being used to view a ship on the water surface.

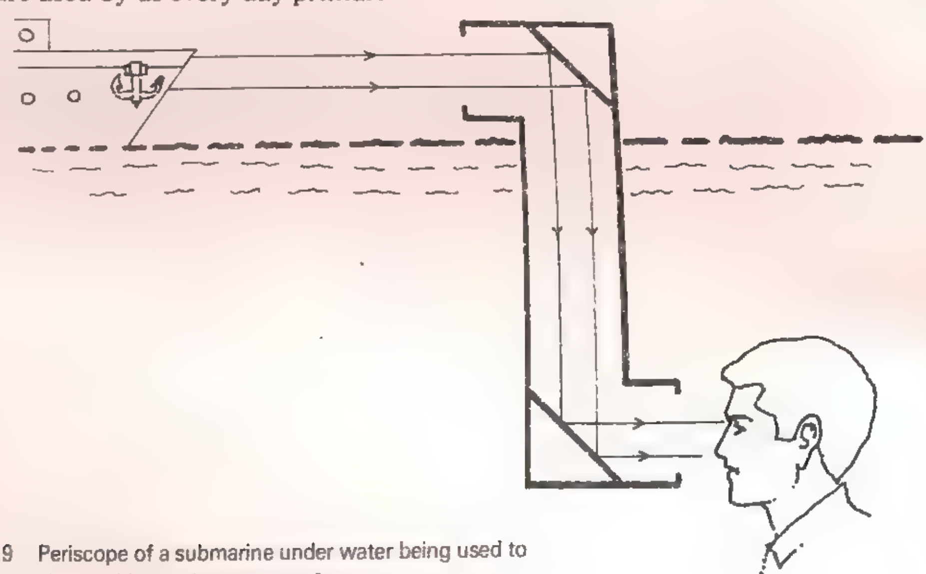


Fig. 6.9 Periscope of a submarine under water being used to view a ship on the water surface.

Kaleidoscope

A kaleidoscope is an interesting toy which makes use of the properties of multiple reflections by plane mirrors kept at an angle, to form beautiful designs.

It contains three plane mirror strips arranged at 60° to each other. Between the strips are coloured glass pieces held between a transparent and a translucent glass plate. The whole arrangement is kept in a cardboard tube with a hole to watch at one end (Fig. 6.10). The glass pieces and their images form beautiful patterns as the tube is rotated.

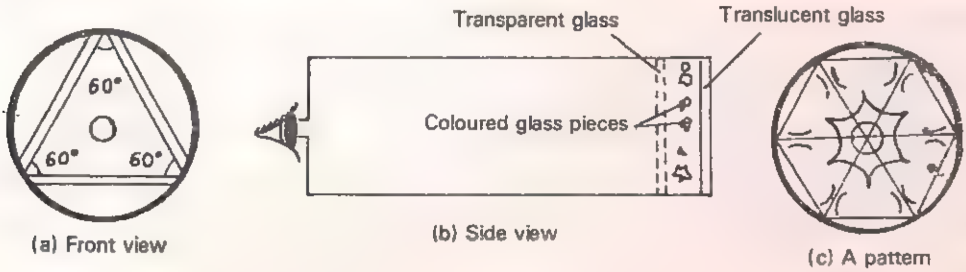


Fig. 6.10 A kaleidoscope.

EXERCISES

1. What happens to a beam of light when it falls on a translucent object? ______________________________

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2. State the laws of reflection. ______________________________

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3. Without drawing rays indicate where the image of O will be formed by plane mirror MP. Can it be seen from a point C?

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4. Vasu saw the images in a plane mirror of two men shaking hands. He later told me that he was surprised to find that they were shaking their left hands instead of their

right hands. Was his observation correct? Why? ______________________________

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5. Compare and contrast the properties of the images formed by (i) a pin hole camera and (ii) a plane mirror. ______________________________

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6. The diagram shows a soldier hiding in a trench. He wants to see the position of the enemy tanks without raising his head. Which instrument should he use? Draw the instrument in the diagram showing the path of light.

7. State true or false.
   (i) We see an object because of the light it transmits.
   (ii) An object with a rough surface would reflect the beam of light incident on it in a particular direction.
   (iii) The angle of incidence is the angle made by the incident beam and the mirror.
   (iv) Two plane mirrors kept perpendicular to each other form an innumerable number of images.
8. Fill in the blanks.
   (i) ____________________ is a toy working on the principle of multiple image formation by inclined mirrors.
   (ii) The image formed by the projector in a cinema hall is a____________________ (real/virtual) image.
   (iii) The image formed by a pair of binoculars is a ____________________ (real/virtual) image.
   (iv) The light that passes through an object is called ____________________ light.
   (v) Reflection from a rough surface is called ____________________ reflection.

7

Oscillatory Motion and Sound

7.1 Oscillations and Vibrations

Activity 1: Make a simple pendulum by tying a stone to a 50 cm long thread. Tie the other end of the thread to a support so that the stone hangs freely. Allow it to come to rest. Now give a gentle push to the stone. You will find that the pendulum moves to and fro or **oscillates** about its rest or mean position A. As the pendulum moves from position A to B, back to A, from A to C and back to A, it completes one **oscillation** (Fig. 7.1). Measure the number of oscillations the pendulum makes in one second. This is known as the **frequency** of oscillations. The time taken by one oscillation is called the **time period** of oscillation and can be found by a simple formula.

Time period, $T =$

$$\frac{1}{\text{no. of oscillations per second}} = \frac{1}{\text{frequency}}$$

Activity 2: Cut a rubber band. Hold one end of it in your mouth and the other end in your hand and stretch it. Now pull it with the other hand and release it (Fig. 7.2). What happens to the rubber band?

You will notice that it starts moving to and fro or **vibrating**, and it also emits a sound. Notice that while vibrating its shape changes, unlike a pendulum whose shape remains the same while oscillating.

Fig. 7.1 Oscillations in a pendulum.

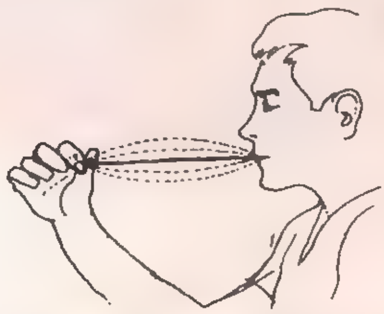


Fig. 7.2 Vibrations in a stretched rubber band produce sound.

Activity 3: Take a tuning fork and strike its prongs against a rubber pad. What two things do you notice? You will find that:

(i) Its prongs start vibrating. You can feel the vibrations with your hand. If you touch the prongs gently on the surface of water taken in a trough, ripples are produced in the water (Fig. 7.3) .

(ii) The vibrating tuning fork emits a sound.

These experiments show that sound is produced by the vibration of objects.

Sound can also be produced by vibration of air. When you blow air into a small bottle, it produces vibrations in the air in the bottle and a sound is produced (Fig. 7.4). Similarly, sound is produced by vibration of air in a flute or a bugle.

Loudness

Gently strike a string of a sitar or guitar. A soft sound is produced. Strike the string harder, the sound produced is louder. When you strike the string harder, it is displaced more from its position. The maximum distance moved by a vibrating body from its rest position is called its **amplitude.** Therefore *the greater the amplitude the louder is the sound produced.*

Pitch

The voice of a girl is shriller than that of a boy Children generally have a shriller voice than adults. What determines the shrillness or flatness of a sound? It is determined by the frequency or the number of vibrations that the body producing the sound makes in one second. *The higher the frequency the shriller the sound.* A sound of high frequency is said to have a high **pitch.** A sound of low pitch has a low frequency.

Frequency of sound is measured in hertz (Hz), or number of vibrations per second. In a tuning fork of frequency 512 Hz, the prongs make 512 to and fro vibrations per second.

7.2 Propagation of Sound

Activity 4: Take a bell jar and suspend an electric bell in it. Take out the electric wires through an air tight cork and connect them to a battery with a switch. Keep the bell jar over a flat disc with a hole connected to a vacuum pump (Fig. 7.5a). Grease the edges of the jar so that air cannot go in. When you press the switch, the hammer of the electric bell strikes the gong and you can hear the sound. Now start the

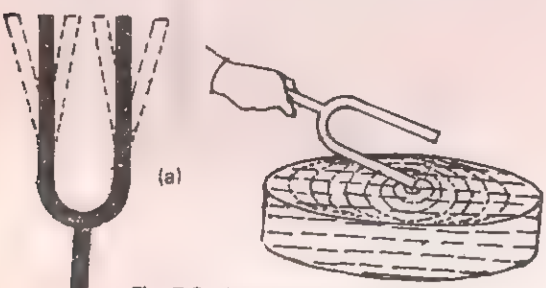


Fig. 7.3 Vibrations in a tuning fork

Fig. 7.4 Sound can be produced by vibrations in air.

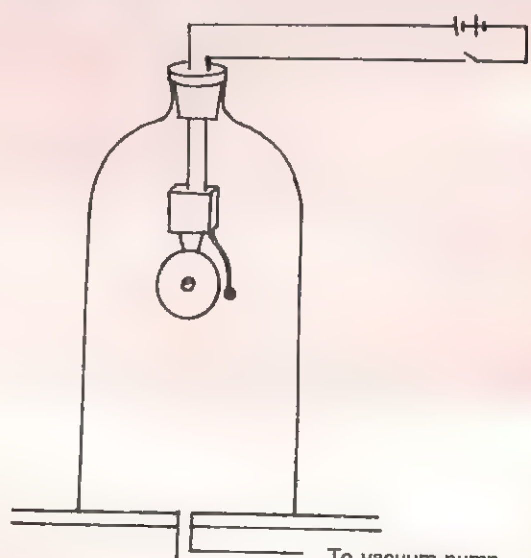


Fig. 7.5 Sound requires a medium to travel.
(a) Sound can travel through air.

vacuum pump and remove the air slowly from the bell jar. You will find that the sound becomes fainter and fainter and ultimately disappears. But the hammer can still be seen striking the gong.

This experiment clearly shows that air is required for sound to travel. Can sound travel through solids or liquids?

Activity 5: Take a wooden plank and press your ear at one end of it. Ask a friend to gently knock at the other end (Fig. 7.5b). You will be able to hear the sound very clearly. This shows that sound can travel through solids.

Activity 6: Fill a balloon with water and press it to your ear. Scratch the other end of it with your fingers (Fig. 7.5c). You will find that the sound reaches your ears. Thus sound can also travel through liquids.

We find, therefore, that sound can travel through air, liquids and solids. In the absence of any medium, sound will not be transmitted.

Fig 7.5 (b) Sound can travel through solids.

Fig. 7.5 (c) Sound can travel through liquids.

7.3 Sound Waves

A vibrating body has mechanical energy. As it vibrates it loses its energy to the surroundings. A part of the mechanical energy is changed into sound which travels to us in the form or waves.

There are two kinds of waves—transverse and longitudinal.

Transverse Waves

While sitting near a pond you may have seen ripples or waves of water spreading out on the water surface when you throw a stone in the pond. You may also have noticed that if there are pieces of paper or dry leaves floating in the water, they only move up and down, and do not move in the direction of motion of the waves.

The water surface would look as shown in Fig. 7.6. The water particles would only move up and down while the wave moves forward.

Such a wave motion, in which the *vibrating particles move perpendicular to the direction of motion of the wave is called* **transverse** *wave motion.*

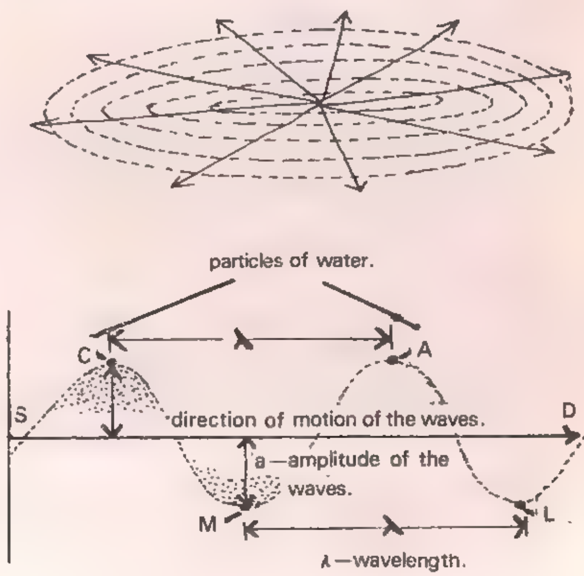


Fig. 7.6 Transverse waves in water.

Longitudinal Waves

Sound produced by a vibrating body also spreads out in the form of waves, but the nature of the waves is different.

Consider a vibrating prong of a tuning fork.

When the fork is not vibrating the air is undisturbed. As the prong A moves to the extreme right position it compresses the air adjacent to it and a **compression** is formed (Fig. 7.7). As it then moves to the extreme left the air adjacent to it becomes rarefied and we say that a **rarefaction** is formed. When the prong is again in the extreme right position a compression is again formed. Thus the vibration produces waves of compressions and rarefactions, which travel to our ear and produce the sensation of sound.

Just as in the transverse waves, the particles themselves move only to and fro about their mean position and do not move along with the wave. However, in this case the particles move to and fro in the direction of motion of the waves. Such a wave motion in which the *particles vibrate in the same line as the direction of propagation of the wave, is known as* **longitudinal** *wave motion.*

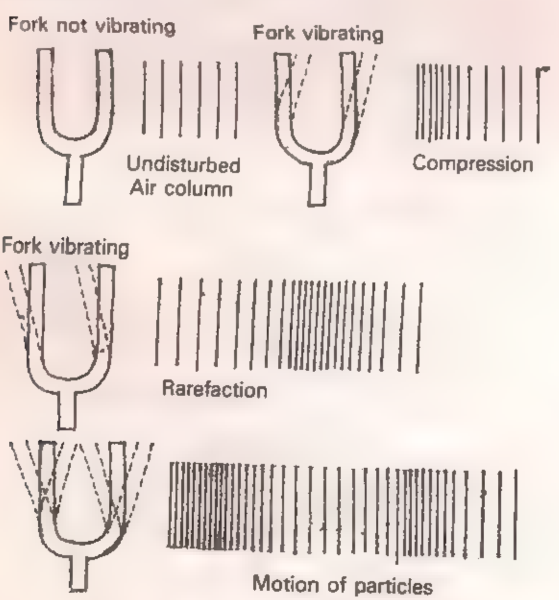


Fig. 7.7 Longitudinal waves produced by a vibrating tuning fork.

7.4 Speed of Sound

While watching a cricket match from the stands you may have noticed that the bat seems to strike the ball a fraction of a second before the sound is heard. This occurs because the speed of sound in air is only about 330 m per second, whereas the speed of light is 300,000 km per second. Suppose you are sitting about 110 m away from the batsman. Light travels this distance in almost no time whereas sound takes ⅓rd of a second to reach you. Thus you hear the sound ⅓rd second after seeing the bat strike the ball.

Thunder and lightning always occur simultaneously. But we hear thunder a few seconds after we see lightning for the same reason.

Sound travels faster than air in liquids and even faster in solids.

7.5 Reflection of Sound

Activity 7: Keep a ticking watch in a cardboard box. If you stand away from the box you will not be able to hear the sound. Now keep a card sheet above the box and tilt it till you can hear the sound. In this position the sound is reflected by the card sheet to your ears (Fig. 7.8).

Replace the card sheet by a piece of sponge or cloth. You will find that the sound is not reflected by the sponge or cloth. The sound is absorbed instead of being reflcted by some materials.

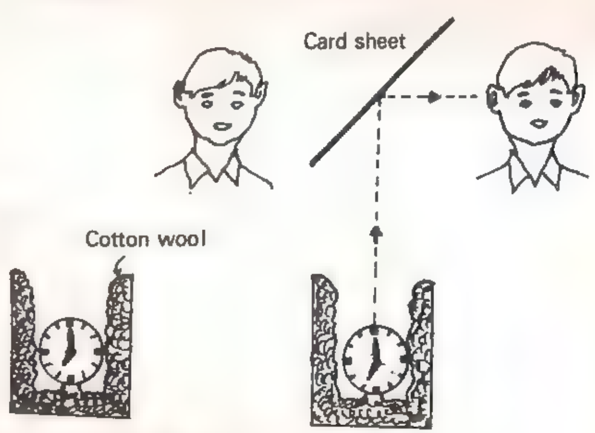


Fig. 7.8 Reflection of sound.

Echo

Stand about 75 m away from a wall and clap your hands. You will hear the sound of the clap again after about half a second. This happens because the sound waves travel to the wall, get reflected by it and again come back to us after about half a second (Fig. 7.9a). The reflected sound is known as an **echo.**

If you know the speed of sound in air and the time after which the echo is received, you can determine the distance of the wall from you.

This principle is often used to determine the depth of a sea. Sound signals are sent from a ship to the bottom of the sea and the time taken for the echo to come back is measured. Then

$$\text{Depth} = \frac{\text{Speed in water} \times \text{Time taken}}{2}$$

The factor of 2 comes in because sound travels to the bottom of the sea and back again, thus covering the depth twice.

Suppose you were standing in a large hall delivering a speech. Your sound will get reflected from the walls of the room and the audience will hear echoes. As a result they will not be able to hear you clearly. Now if all the walls were covered with curtains or any other sound absorbing material, most of the sound would be absorbed and the echo would be eliminated. This arrangement of absorption of sound is necessary in large auditoriums and cinema halls.

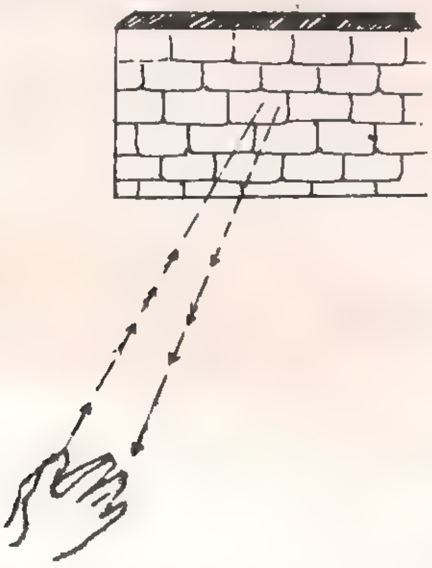
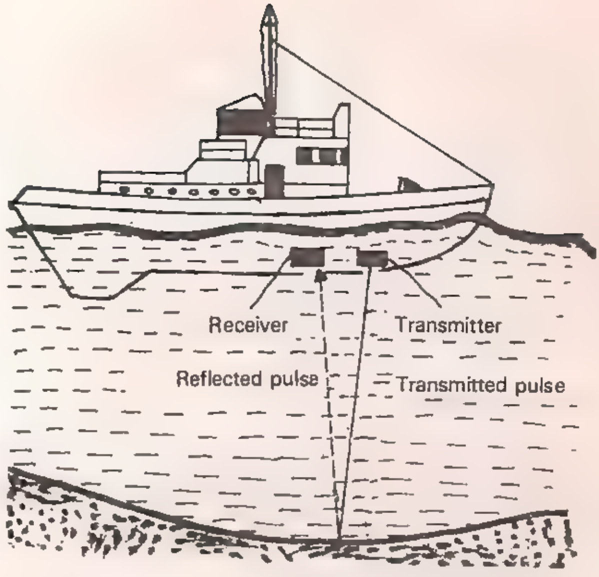


Fig. 7.9 (a) How an echo is produced.



(b) The echo method used to measure the depth of sea.

7.6 Recording and Reproduction of Sound

We know that sound is produced by vibrations. If we have a method of converting the air vibrations produced by sound to the vibrations of a needle and recording these vibrations, we can record sound. This sound can be reproduced by making the needle vibrate again in the same way and converting these vibrations to vibrations of air.

This is exactly how sound is recorded on a gramophone record and then reproduced when we play the record.

Recording

Sound waves from the source are allowed to fall on a membrane which starts vibrating. These vibrations are transferred to a cutter through levers. The vibrating cutter moves over the soft material of a rotating disc and cuts

grooves on it (Fig. 7.10). Once the groove is cut on the entire disc, copies of the disc are made. These copies are the gramophone records we have at home. You can see concentric circles on the records. If you examine these with a magnifying glass, you will see fine grooves having a zig zag path all over the record. In fact there is only one continuous groove starting from the edge and ending at the centre. It is known as the **sound track.**

Reproduction

When we play a record, the needle moves within the groove and vibrates in the same way as the cutter vibrates while recording. These vibrations are amplified and converted to sound vibrations by the speaker.

Sound can also be recorded on magnetic tapes. You will learn about this method in higher classes.

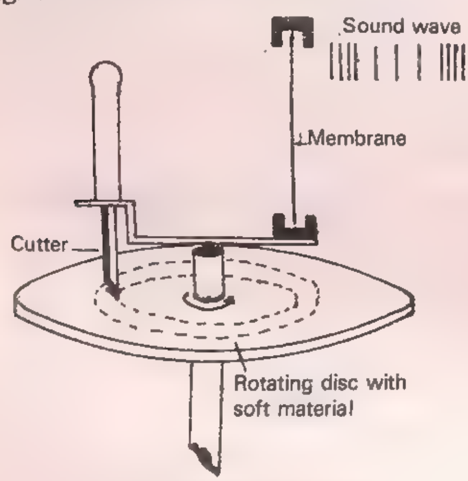


Fig. 7.10 Recording of sound.

7.7 Ultrasonics and Infrasonics

We can listen to the sound of frequency from about 20 to 20,000 Hz. Vibrations above or below this frequency do not produce the sensation of sound in our ears. However, the dog or the cat can listen to sound of frequency above 20,000 also. Sound of frequency less than 20 is known as **infrasonic.**Sound of frequency above 20,000 is known as **ultrasonic.**

7.8 The Human Ear

The human ear consists of a thin membrane called the **ear drum.** When sound is received by the ear drum, it starts vibrating. These vibrations are transmitted by the bones in the middle ear and canals in the inner ear to the **auditory nerve.** This nerve takes the message to the brain.

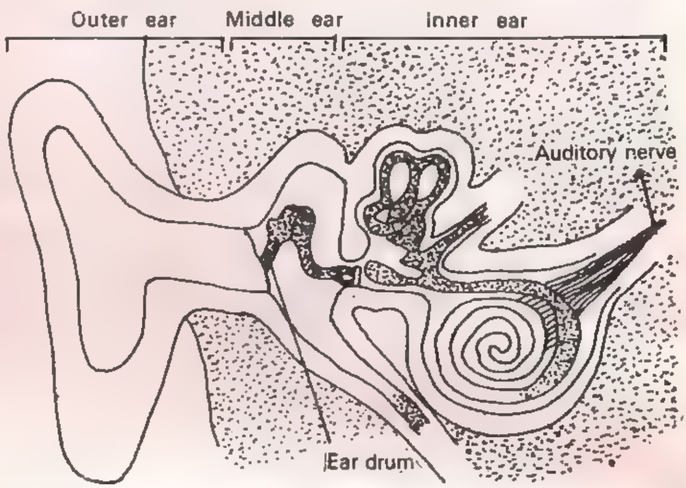


Fig. 7.11 The human ear.

EXERCISES

1. Explain
   (i) Oscillatory motion. ______________________________

____

(ii) Vibratory motion.

2. How is sound produced?

3 What is the difference between transverse and longitudinal waves?

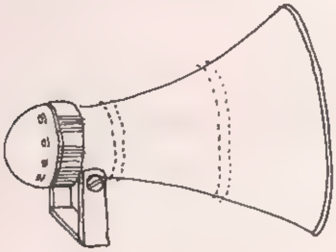
4. Explain the following.
   (i) A boy standing about 200m away from a man shooting a gun heard the sound of the gun more than half a second after the trigger was pressed.

   (ii) If you stand 10m away from a wall and shout you do not hear an echo. But if you stand 100m away from the wall and shout you do hear an echo.

5. The speed of sound in air is 330 m/second. On clapping I can hear the echo from a wall after 1 sec. How far from the wall am I standing?

6. The speed of sound in air is 330 m/sec. The thunder of a storm is heard 4 seconds after the lightning is seen. How far away is the storm raging?

7. Show the compressions and rarefactions in air produced by the loudspeaker shown in the figure.



8. Explain the difference between infrasonic and ultrasonic sound

9. Write true or false.
   (i) Time period of oscillation = 1/frequency of oscillation.
   (ii) Sound can be produced by the vibrations of a solid object only.
   (iii) Loudness of sound depends upon the amplitude of vibration of the source.
   (iv) The lower the frequency, the lower the pitch of sound.
   (v) Sound does not need a medium to travel.
   (vi) If the sun explodes a loud sound will be heard by us.
   (vii) Sound waves are longitudinal.
   (viii) The density of air in a compression will be more than the density in a rarefaction.
   (ix) Speed of sound in a metal is less than in air.
   (x) When a wave moves forward the particles of the medium also move along with it.
   (xi) Sound is converted into mechanical vibrations before being recorded.

10. Fill in the blanks.
   (i) Sound waves reaching the ear are received by the ______
   (ii) The number of times a body vibrates every second is called its ______.
   It is measured in ______ .
   (iii) The greater the amplitude the greater the ______ .
   (iv) Sound of frequency 10,000 Hz would be ______ (more/

less) shrill than sound of frequency 500 Hz.

(v) Sound travels in the form of ______ ______

(vi) Besides gramophone records, sound can be recorded on a ______

11. How is sound recorded on a gramophone record? ______

______

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8

Magnetism

At some time or the other you must have played with magnets and must have been fascinated by its ability to attract nails and pins from a distance. Man has been familiar with magnetism for over 2000 years. The ancient Chinese had found a type of stone in nature which could attract iron pieces. They also discovered that when the stone was suspended freely, it always came to rest pointing roughly in the north-south direction. This stone was named 'lodestone'. Lodestone is a **natural magnet.** Magnets can also be prepared artificially. These are known as **artificial magnets.** The magnets you must have played with were all artificial magnets. Artificial magnets are available in various shapes and sizes. Some of these are shown in Fig. 8.1

8.1 Magnetic and Non-magnetic Materials

Activity 1: Collect several small objects such as copper wire, iron nail, steel pin, plastic pen cap, sewing needle, knitting needle etc. Test them with a magnet. Make two lists, one of objects attracted by the magnet and the other of objects not attracted. What do you find?

You will notice that objects made of iron and steel are attracted by magnets whereas others are not. Iron and steel are known as **magnetic materials.** Other magnetic materials are cobalt and nickel. Wood, plastic, paper etc. are **non-magnetic materials.**

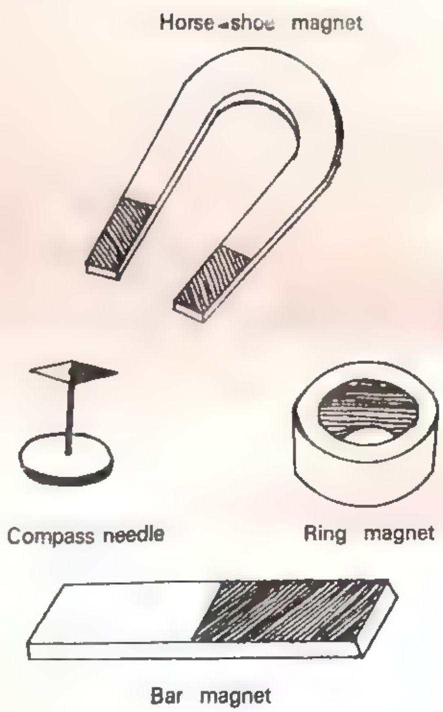


Fig. 8.1 Kinds of magnets.

8.2 Properties of a Magnet

1. Poles of a Magnet

Activity 2: Put some iron filings on a piece of paper. Roll a bar magnet in the filings and lift it up. What do you notice?

You will find that the iron filings are attracted by the magnet and cling to it. But you will notice that maximum iron filings will cling to the magnet at its ends and almost none at the centre (Fig. 8.2). This shows that the attraction is greatest near the ends of the magnet. These regions are known as the **poles** of the magnet.

Repeat the experiment with a horse-shoe magnet. You will again see that maximum iron filings cling to the two ends.

Every magnet has two poles. Let us now study about another property of the poles of a magnet.

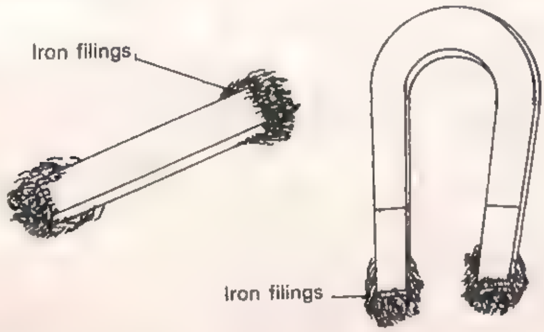


Fig. 8.2 Attraction of a magnet is greatest at the poles.

2. Directional Property

Activity 3: Tie a thread to the middle of a bar magnet and suspend it so that it remains horizontal (Fig. 8.3). Note the direction in which the magnet comes to rest. Now disturb the magnet and let it again come to rest. Take it to another place and again perform the same experiment.

You will find that the magnet *always* comes to rest in approximately the geographical north-south direction. Also, you will find that one particular pole always points towards the geographical north. This is called the **north pole** of the magnet. The other pole always points towards the geographical south—this is known as the **south pole** of the magnet.

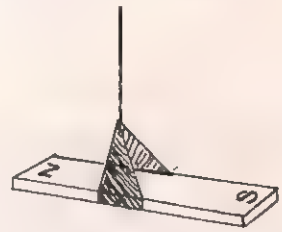


Fig. 8.3 A freely suspended magnet always comes to rest in approximately the north-south direction.

The Magnetic Compass

A magnetic compass consists of a magnetised needle of iron pivoted at the centre so that it is free to move. When kept in a horizontal position it comes to rest in approximately the north-south direction. It is used to find directions and is specially useful for sailors and trekkers.

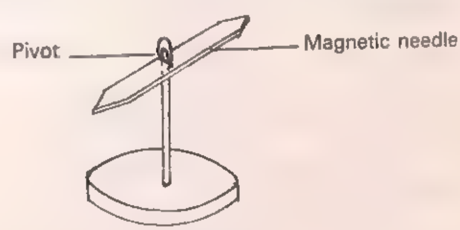


Fig. 8.4 Magnetic compass

3. Attraction and Repulsion

Activity 4: Take two bar magnets. Suspend one of them as in Activity 3. Bring the north pole

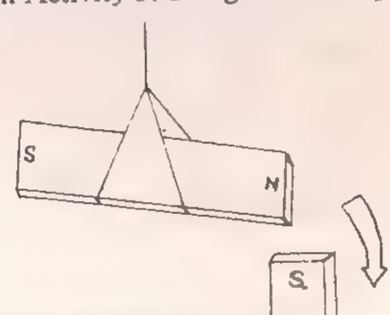
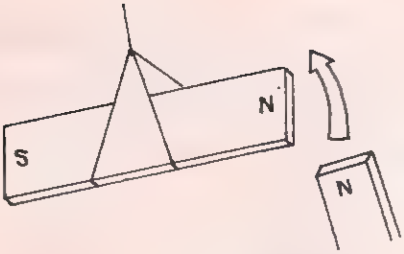


Fig. 8.5 (a) Ulike poles attract



(b) Like poles repel.

of the other magnet near the south pole of the suspended magnet. You will find that the two poles attract each other (Fig. 8.5 a)

Now bring the north pole of the other magnet near the north pole of the suspended magnet. You will notice that *the two poles repel each other* (Fig. 8.5b). If the south poles of the two magnets are brought together they will also repel each other.

We therefore find that a north pole attracts a south pole but repels a north pole. Similarly a south pole attracts a north pole but repels a south pole. In other words *like poles repel and unlike poles attract each other.*

4. Magnetic Poles Exist in Pairs

If you take a bar magnet and break it into two pieces what do you expect? Perhaps you will say that one of the pieces will have only the north pole and the other only the south pole. This, however, is not true. When a magnet is broken into two pieces, *each part becomes a magnet with a north pole and a south pole* (Fig. 8.6). No matter how many pieces the magnet is broken into, each piece will always have a north pole and a south pole.

Thus in a magnet the north and south poles always exist in pairs. *A magnetic pole cannot be isolated.*

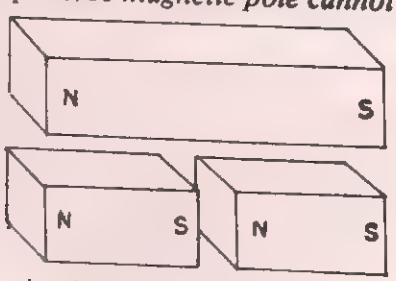


Fig. 8.6 Magnetic poles always exist in paris.

8.3 Test for Magnets

A magnet will attract the opposite pole of another magnet or an unmagnetised piece of a magnetic material. But a magnet will only repel the like pole of another magnet. It will never repel an unmagnetised object. Repulsion can therefore be used to test whether the given object is a magnet or not. Bring the object close to the two poles of a magnet. If one of the poles attracts and the other repels the object, then the object is a magnet. If both the poles attract the object, it is not a magnet.

Thus *repulsion is a sure test for a magnet.*

8.4 Making and Destroying a Magnet

Making a Magnet

There are several methods of making artificial magnets. Let us study a simple method which you can use to magnetise an iron nail or needle using a bar magnet.

Activity 5: Take a long iron nail or a needle and place it on a table. Hold one pole (say the north pole) of a strong bar magnet over the nail. Rub it from one end of the needle to the other. Then lift the magnet well away and bring it down once again to the first end (Fig. 8.7). Repeat the procedure about 50 times. Test whether the nail has become a magnet and find out the poles.

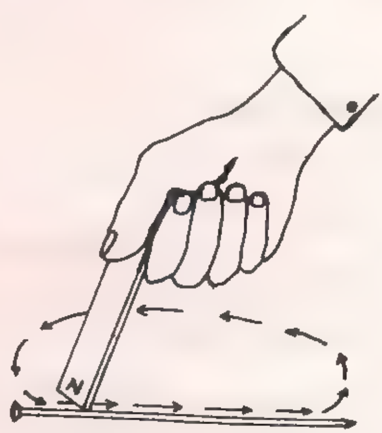


Fig. 8.7 Magnetising an iron nail.

You will discover that the end at which you started rubbing becomes a north pole and the other end becomes a south pole.

Magnets can also be made by passing an electric current through a wire wound around an iron piece. You will study about this in higher classes.

Destroying a Magnet

A magnet can be destroyed by hammering it violently or by heating it. When handling a magnet you should therefore not let it fall on the ground.

8.5 Magnetic Field

Activity 6: Place a compass needle on a table and bring a magnet slowly near it from a large distance. You will find that at first the needle points in the north-south direction and is not affected by the magnet. The needle changes direction, showing the effect of the magnet when the magnet is close to it. This shows that the effect of a magnet is felt over some distance only. The space over which the effect of a magnet is felt is known as the **field** of the magnet. If you repeat the experiment with a stronger magnet you will find that the needle is affected when the magnet is at a greater distance. Thus the field of a stronger magnet extends over a larger space.

8.6 Magnetic Lines of Force

Activity 7: Place a magnet on a smooth sheet of paper kept on a table and sprinkle iron filings around it. On tapping the sheet, you will observe that the iron filings arrange themselves in a definite pattern around the magnet (Fig. 8.8). The lines along which the iron filings lie are known as **lines of force**. They indicate the lines along which magnetic forces act.

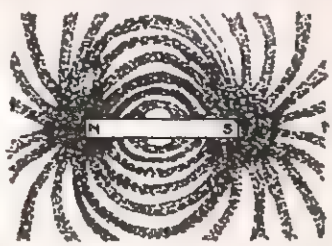


Fig. 8.8 Magnetic lines of force.

8.7 Earth's Magnetism

You have seen that a magnet suspended freely in air points approximately in the north-south direction. This suggests that the Earth has a magnetic field around it.

The Earth behaves as if a huge bar magnet was buried deep inside it, with its south pole pointing approximately towards the geographical north and its north pole pointing approximately towards the geographical south pole (Fig. 8.9). Scientists believe that this may be because of deposits of magnetic material in the earth.

8.8 Uses of Magnetism

Magnets are useful to us in a large number of ways. You have already learnt about the compass needle.

The generators in power houses or dams which generate electricity use magnets. The **electric motor** which rotates your fans, the turntable of your record player, the cassette of your tape recorder or the drum of your washing

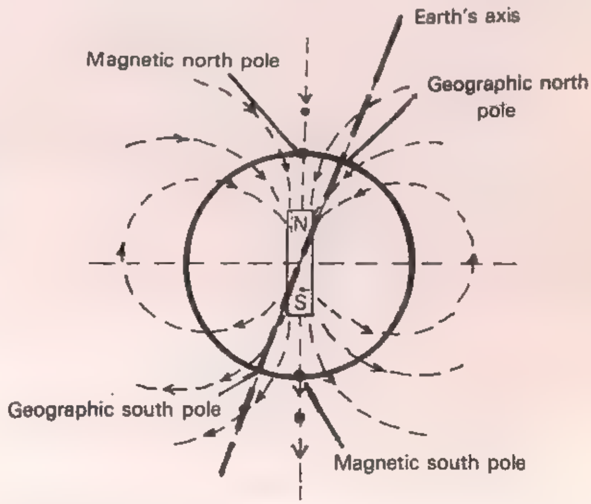


Fig. 8.9 The Earth's magnetic field.

machine, all utilize magnets.

Magnets are used in **speakers** of radios, televisions, tape recorders and record players and also in the earpiece of telephones.

The tape used in tape recorders are coated with a magnetic material. **Magnetic tapes** are now extensively used for storing information in computers.

Try and discover for yourselves other ways in which magnets are useful to us.

EXERCISES

1. Distinguish between natural and artificial magnets. ____________________

____

____

____

2. Name
   (i) three magnetic materials. ____________________

   ____

   (ii) three non-magnetic materials. ____________________

   ____

3. (i) What are 'poles' of a magnet? ____________________

   ____

   ____

   (ii) How many poles are there in a magnet? ____________________

   ____

   (iii) Name the poles of a magnet. How are these names derived? ____________________

   ____

   ____

   (iv) Can a pole of a magnet exist alone? ____________________

4. Using another magnet how can you test if a given piece of iron is a magnet? ______

____

____

____

____

5. Draw a diagram to show how you can magnetise a small iron rod using a bar magnet. Show the poles in the iron rod after it is magnetised.

6. Why should a magnet not be dropped on the ground? ______________________________

____

____

7. What do you understand by
   (i) the 'field' of a magnet. ______________________________

   ____

   ____

   (ii) magnetic lines of force. ______________________________

   ____

   ____

8. Does the earth really have a bar magnet buried in it? ______________________________

____

9. Mention two ways in which magnets are useful to us. ______________________________

____

____

____

____

10. Fill in the blanks.
   (i) A magnet ______________ (attracts/does not attract) copper nails.
   (ii) When a magnetic needle is freely suspended, its______________pole points approximately towards the geographic north.
   (iii) Like poles______________. Unlike poles______________.
   (iv) ______________ is a sure test for a magnet.
   (v) ______________ and ______________ destroy a magnet.

11. Mark true or false.
   (i) The geographic north pole and the earth's magnetic south pole do not coincide exactly with each other.
   (ii) A magnet will attract an aluminium spoon.
   (iii) In a magnet the attractive power is equally distributed over the entire length.
   (iv) The north pole of magnetic compass needle points exactly towards the geographic north.
   (v) If there were no magnets we would not have had electricity in our homes.

9

Electricity

You will probably be familiar with the word 'electricity'. It is electricity that lights bulbs, runs fans, refrigerators, heaters, air conditioners and a number of other electrical appliances we have at home. You must have noticed that wires from a socket should be connected to the appliance and the electric switch should be in the 'on' position to make the appliance work.

We have seen earlier that electricity is a form of energy. It can be converted into other forms of energy such as heat (in a room heater), light (in an electric bulb), mechanical energy (in a fan), sound (in an electric bell) etc. Let us study about electricity and the effects it produces.

9.1 Electric Force

Activity 1: Hang two balloons with the help of threads so that they are about 10cm apart. Rub them together and release them. What do you notice. The balloons push each other even from a distance and rest slightly apart (Fig. 9.1a).

Activity 2: Brush your dry hair with a plastic comb and bring it over small pieces of paper. You will find that the pieces of paper are attracted to the comb and stick to it (Fig. 9.1b).

In both these experiments, the effect of rubbing is to produce a type of force which acts from a distance. The force can attract as well as repel bodies. It is known as **electrostatic force.** On being rubbed, some bodies acquire a property known as **electric charge**. The body is then said to be **electrically charged** or simply **charged**. It can then attract or repel other bodies.

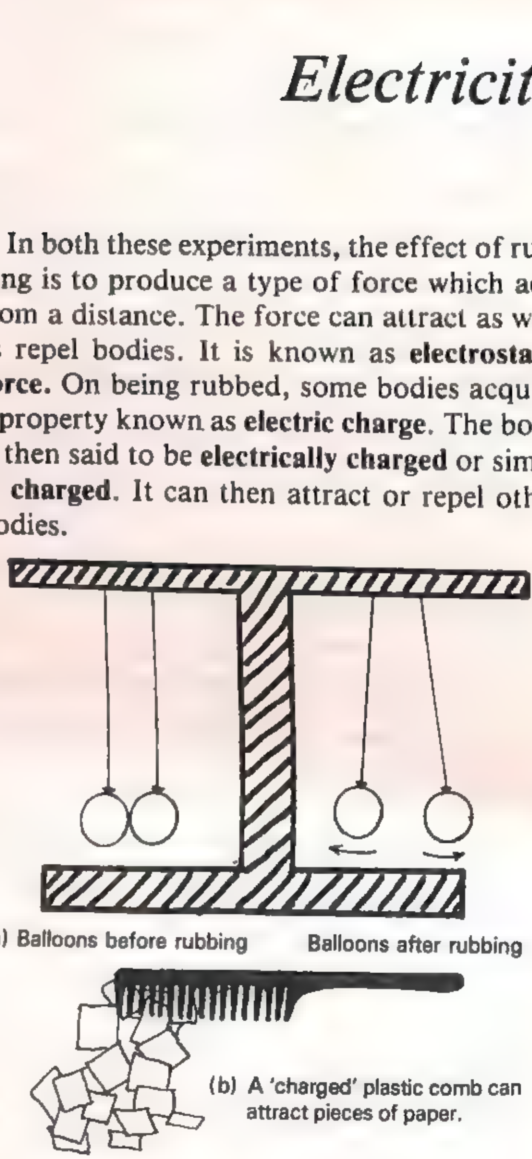


Fig. 9.1 The electrostatic force.

Activity 3: Rub an ebonite rod with fur and suspend it by a thread. Bring another ebonite rod charged in the same way near it. You will find that it repels the suspended rod (Fig. 9.2a). Now rub a glass rod with silk and bring it near the suspended rod. The glass rod will attract the ebonite rod (Fig. 9.2b). If the experiment is carried out with two similarly charged glass rods, they will be found to repel each other.

It is clear from this experiment that the charges on the ebonite and glass rods are of different kinds. We call the charge acquired by the glass rod when it is rubbed with silk as **positive,** and the charge acquired by the ebonite rod when rubbed with fur as **negative.**

The experiment also shows that a pair of positively charged bodies or a pair of negatively charged bodies repel each other whereas a positively and a negatively charged body attract each other. In other words: *Like charges repel each other and unlike charges attract each other.*

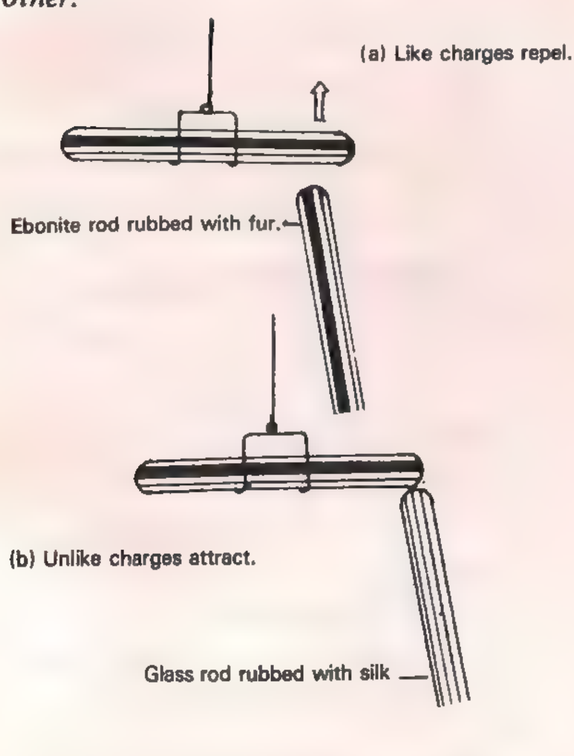


Fig. 9.2 Like charges repel, unlike charges attract.

9.2 The Electroscope

Activity 4: Suspend a small paper cylinder by a thread. Bring a negatively charged ebonite rod near it. The cylinder will be attracted to the rod. Now touch the cylinder with the rod. The cylinder will now be repelled by the ebonite rod.

This shows that after the cylinder was touched by the rod, *it acquired a part of the charge of the rod.* Thus, a body can be charged by touching it to another charged body. The charge it acquires is similar to the charge on the charged body.

This principle is used to make the electroscope which is used to detect and measure the quantity of charge. It consists of a metallic rod ending in a metallic head at the upper end. At the lower end are attached two thin metallic leaves. The lower portion is enclosed in a bell jar.

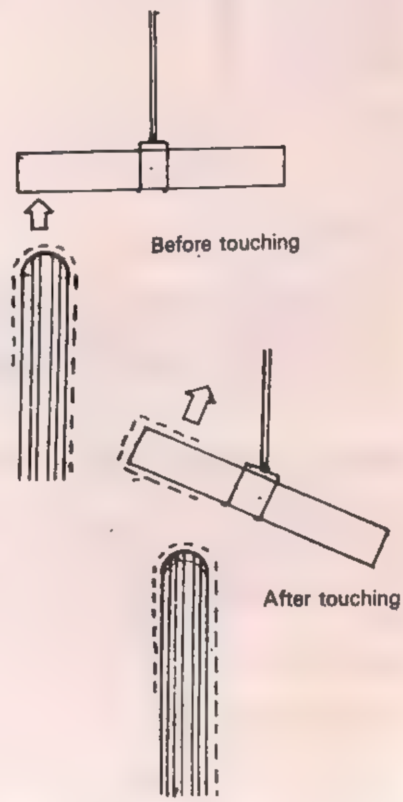


Fig. 9.3 A body can be charged by touching a charged body to it.

Activity 5: Touch a charged rod to the head of an electroscope. You will find that the leaves diverge (Fig. 9.4b).

This happens because a part of the charge on the rod gets transferred to the rod and the leaves. Since both leaves get similarly charged, they repel each other and diverge. The amount of divergence is a measure of the amount of charge on the body.

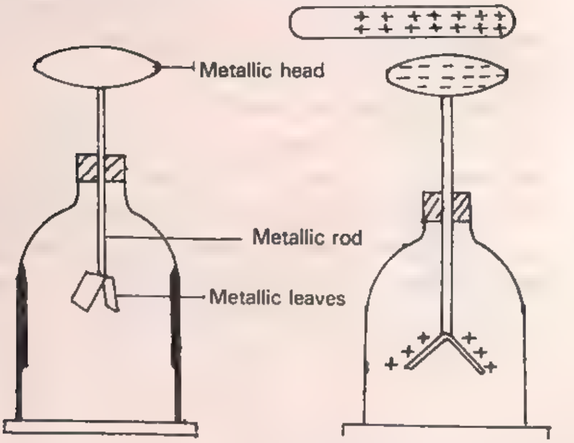


Fig. 9.4 (a) An electroscope. (b) Detecting a charge with an electroscope.

9.3 Flow of Charge

When a charged rod is touched to the head of an electroscope the leaves also get charged. How does this happen? How does the charge reach the leaves?

Activity 6: Charge the leaves of a gold leaf electroscope. Hold a metallic wire or rod with the help of a plastic or wooden clip and connect its head to the head of another uncharged electroscope. You will notice that the divergence of the leaves of the charged electroscope decreases while the leaves of the uncharged electroscope diverge. This suggests that some of the charge may have 'flown' from the charged electroscope to the uncharged one through the metallic wire. Perform the same experiment using a plastic ruler. You will find that there is no change in the divergence of the leaves in this case. This shows that while charge can flow through a metallic wire, it cannot flow through plastic.

Carry out the experiment with other materials such as paper clip brass, wood, glass, thread etc.

Materials such as metals, through which charges can flow are known as conductors. Materials such as plastic, wood, thread, through which charges cannot flow are known **as non-conductors** or **insulators.**

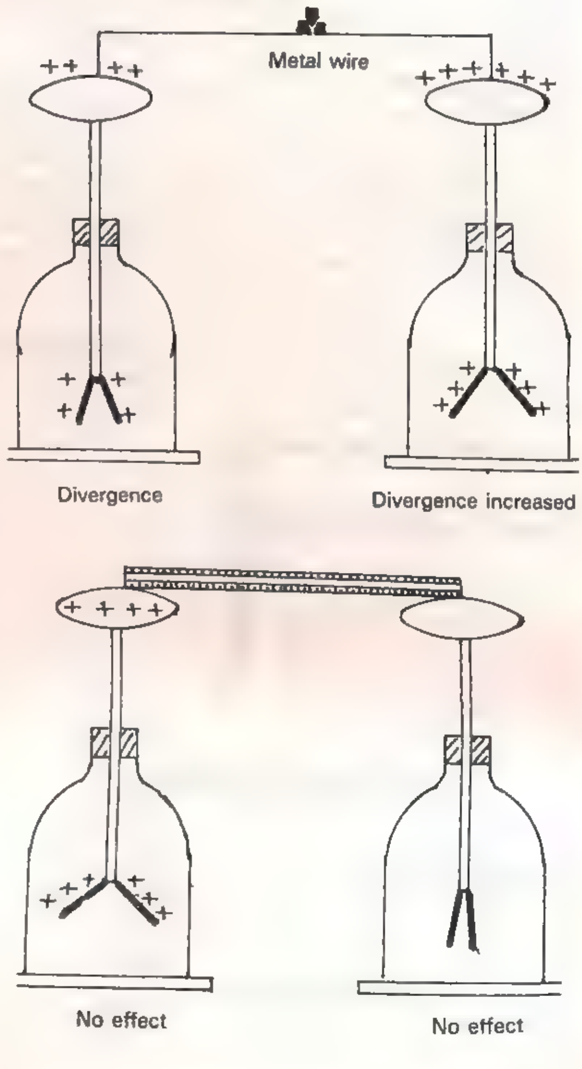


Fig. 9.5 Conductors and non-conductors.

You are perhaps wondering why you should hold the metal wire with a wooden or plastic clip (i.e. a clip made out of a non-conductor) and not with your hands. To understand this touch the head of a charged electroscope with your hands. You will find that the leaves collapse. The charge has flown through your body to the ground. The human body is therefore a conductor of charge.

9.4 Electric Current

When charges flow in a conductor they give rise to an electric current, just as flowing water produces a water current. It is this electric current which flows through electric wires in bulbs, fans, heaters and makes them work.

By connecting a charged body to an uncharged body through a conductor we can make an electric current flow for a short while. But for operating electrical appliances we need a continuous current. This can be produced by huge **dynamos** in power stations or even by tiny dry cells we use in torches or by a car battery.

9.5 Dry Cell

Fig. 9.6 shows an ordinary torch or dry cell. The brass cap at one end serves as one of the terminals. It is known as the **positive terminal**. It is connected to a carbon rod inside the cell The other terminal, called the **negative terminal,** is the zinc container in which the cell is made. A card or plastic covering protects the container from the sides. The lower part of the container serves as the negative terminal.

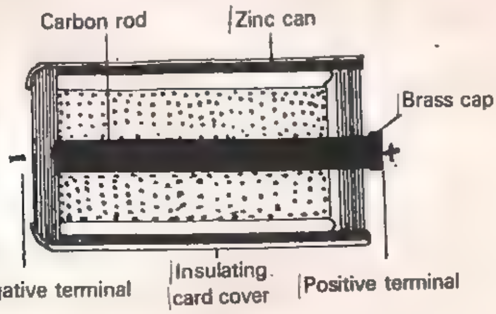


Fig. 9.6 A dry cell.

9.6 Electric Circuit

Activity 7: Take a torch bulb and connect one of its terminals through a metallic wire to a cell. The bulb does not glow. Take another metallic wire and connect the other terminal of the bulb to the second terminal of the cell. The bulb glows (Fig. 9.7a). If one of the wires is broken the bulb will stop glowing.

When the wires are correctly connected to the cell such that it glows, it is said to form a **complete** or **closed circuit.** If one of the wires is broken an **open circuit** results.

You know that an electric switch can switch on or off an electric appliance. Break one of the wires in the circuit and connect its two ends to the two terminals of a switch. When the switch is 'on' the wires get interconnected within the switch and the circuit is closed. In the 'off' position the wires are not connected and the circuit is open (Fig. 9.7b).

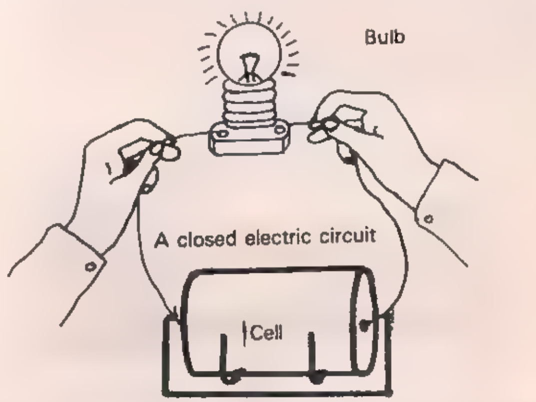


Fig. 9.7 (a) An electric circuit containing a cell and a bulb.

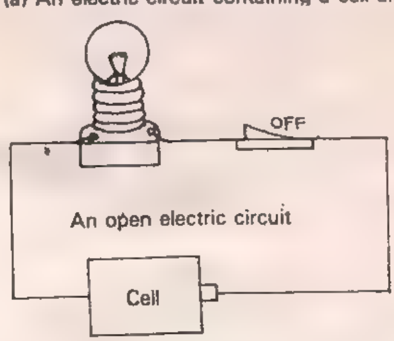


Fig. 9.7 (b) An electric circuit containing a cell, a bulb and switch.

9.7 Conductors and Insulators

Activity 8: Remove one of the wires in the above circuit and substitute it by a plastic ruler. You will find that the bulb does not glow. Test with other materials such as a metallic pin, a glass rod, a brass rod, wood, thread etc. as you did in Activity 6. You will again find that while metallic objects are conductors of electricity, glass, wool, thread etc. are non-conductors of electricity.

This also shows that electric current is nothing but a flow of electric charges.

9.8 Effects of Electric Current

(i) Electric Current Produces Heat

A torch bulb becomes hot when it is glowing. In a room heater the wire (known as **filament**) is made red hot by passing electric current through it (Fig. 9.8a). Similarly, the electric iron has a filament which becomes hot, when electric current passes through it (Fig. 9.8b). It is therefore a common experience that electric current produces heat.

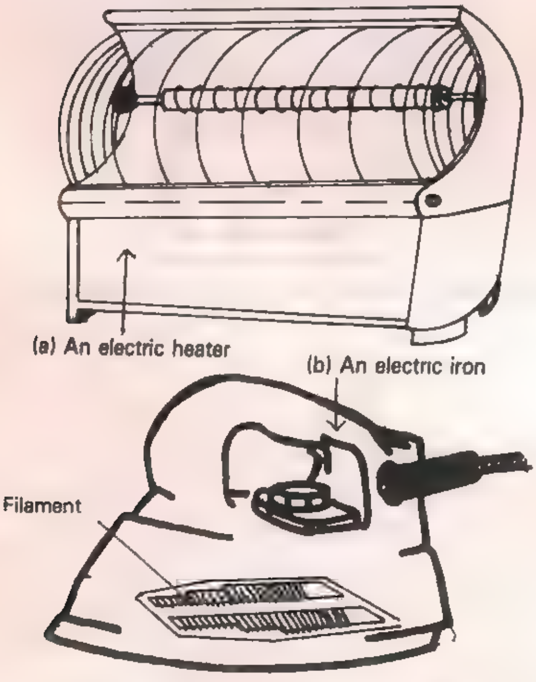


Fig. 9.8 Electric current produces heat.

(ii) Electric Current Produces a Magnetic Field

You know that a magnet has a magnetic field around it. If a compass needle is brought in the field of the magnet it gets deflected.

Activity 9: Connect a metallic wire to a cell through a switch. Hold the wire just above the needle and switch on the current (Fig. 9.9). What do you observe?

The compass needle gets deflected. This shows that electric current flowing through a wire *produces a magnetic field around it*. This effect of an electric current has wide applications. It is used, for example, in electric motors, which are used in fans, tape recorders, washing machines etc. It is also used in speakers fitted in radios, televisions or in our telephones.

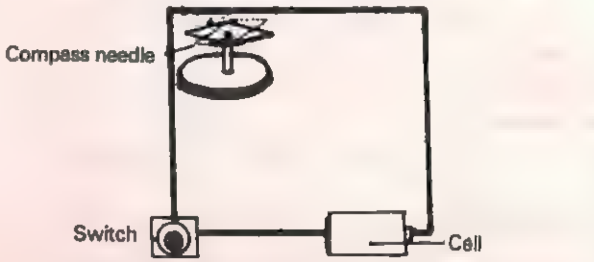


Fig. 9.9 Electric current produces a magnetic field.

(iii) Electric Current Can Bring About Chemical Changes

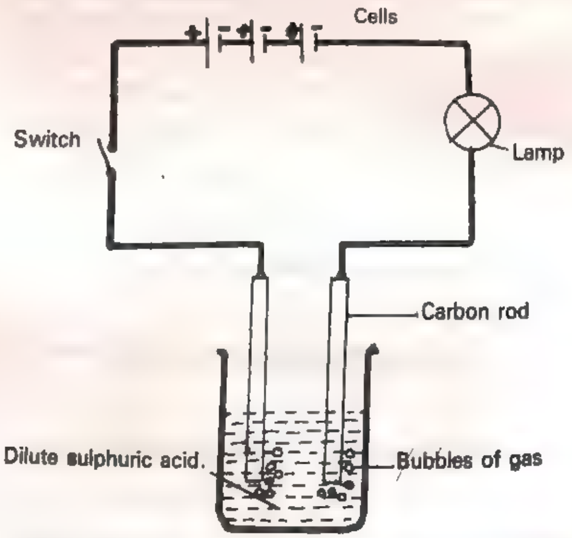


Fig. 9.10 Electric current brings about chemical changes.

Take dilute sulphuric acid in a beaker. Connect two pieces of pencil leads or two carbon rods (you can get carbon rods by breaking old dry cells) to cells through a torch bulb and a switch (Fig. 9.10). Dip these carbon rods in the dilute sulphuric acid solution and switch on the current. You will find that the bulb glows. This shows that dilute sulphuric acid is a conductor. Look at the rods carefully. Can you observe bubbles of some gas coming out near both the rods? Switch off the current. The bubbles no longer come out. Therefore, the electric current must be producing some chemical changes in the liquid when it flows through it

If you dip the carbon rods in kerosene you will find that it does not conduct electricity.

Thus there are certain liquids which conduct electricity and in which an electric current produces chemical changes. Such liquids are known as **electrolytes.** Mercury is a conductor of electricity but is not an electrolyte as the current does not produce any chemical changes in it.

This effect of current is used, for example, in a process called **electroplating,** where a thin layer of a metal such as chromium, is deposited on another metal such as iron, to give it a shine and to protect it from rusting.

EXERCISES

1. (i) What is electrostatic force? ______________________

____

____

(ii) Explain what you mean by positive and negative charges. ______________________

____

____

____

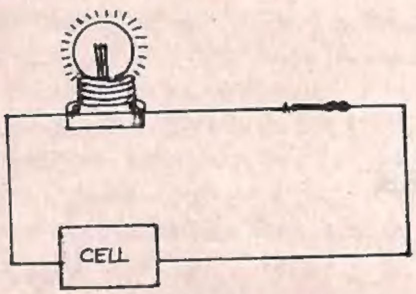
____

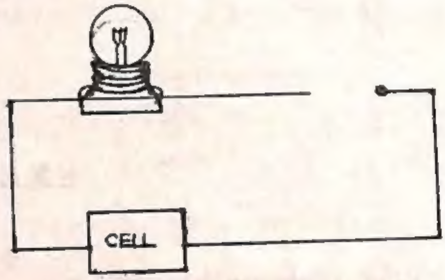
2. (i) Draw a labelled diagram of an electroscope.

(ii) If a charged rod is touched to the head of the electroscope, the leaves diverge. Why?

(iii) Explain what will happen if the rod used in an electroscope is made of plastic instead of metal.

In the following figures say which circuit is open and which is closed.





4. State the three effects of an electric current. State one use of each.

5 Draw a labelled diagram of a dry cell.

6. State true or false.
   (i) Electric current is produced when electric charges flow.
   (ii) Like charges attract, unlike charges repel each other.
   (iii) A body can only be charged by rubbing.
   (iv) The amount of divergence that a charged body produces in the leaves of an electroscope is independent of the amount of charge on the body.
   (v) When a charged body is touched to an uncharged body, the amount of charge on the charged body reduces.
   (vi) Electricity is a form of energy.
7. Fill in the blanks.
   (i) The instrument used to detect and measure quantity of charge is known as an ____________
   (ii) The human body is ____________ (conductor/non-conductor) of electricity.
   (iii) Moving charges give rise to an ____________ ____________.
   (iv) If a wire in a closed circuit is broken, the circuit becomes ____________
   (v) Dilute sulphuric acid is a ____________, mercury is not ____________, though it is a ____________ of electricity.

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